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Civilian Radioactive Waste Management System
Management & Operating Contractor

1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report

Revision 00

August 31, 1998

Prepared for:

U.S. Department of Energy
Office of Civilian Radioactive Waste Management
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1. INTRODUCTION

Section 1 describes the purpose and scope of this report, the organizational responsibilities and methodology for the development of this report, an overview of the Waste Acceptance, Storage and Transportation (WAST) Project, and an overview of the report's sections.

1.1 PURPOSE

The purpose of the 1998 WAST Life Cycle Cost (LCC) Report is to provide an estimate of life cycle costs associated with the WAST Project, along with the cost basis data from which the life cycle costs were developed. By doing so, it provides a detailed basis of estimate (BOE) for the WAST portion of the 1998 Civilian Radioactive Waste Management System (CRWMS) Total System Life Cycle Cost (TSLCC) Report.

This document also serves as a summary of WAST LCC data, and serves as the basis for cost comparisons in future WAST and total Program system trade studies. Note that this report does not contain any discussion of WAST life cycle costs that include Source Selection Information; this information is contained in the Source Selection Sensitive version of this report (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management Systems, Management and Operating Contractor.).

1.2 SCOPE

The 1998 WAST LCC Report provides the BOE for the development, operation, and decommissioning of all WAST system elements.

Section 2 provides the results of a LCC analysis for the current Program Approach "Reference Case Scenario". The scenario assumes no Centralized Interim Storage Facility (CISF), a single repository, and the use of Regional Service Contractors (RSCs) to transport commercial spent nuclear fuel (SNF) and defense wastes from Purchaser/Producer sites to the Monitored Geologic Repository (MGR). This scenario and the principle assumptions associated with it are described in detail in the *Waste Acceptance, Storage, and Transportation (WAST) Cost Estimate Assumptions Document* (CRWMS M&O 1998c). The key assumptions from this document are included in Appendix B of this report.

1.3 RESPONSIBILTIES AND METHODOLOGY

This section identifies the offices responsible for providing input to this document and describes the general methodology used in its development.

1.3.1 Responsibilities

The following managers are responsible for the contents of this document:

- The Assistant General Manager, Waste Management and Integration is responsible for approving this report.

- The Waste Management and Integration Systems Engineering and Integration Office is responsible for compiling this report.

- The Waste Acceptance and Transportation Office Manager is responsible for providing and approving input data on waste acceptance, transportation, and Section 180(c).

1.3.2 Methodology

The costs for this scenario were developed as reference costs representing the current program approach as documented in the Strategy and Program Plan Revision 2 (DOE 1998. *OCRWM Strategy and Program Plan FY 1999 – FY 2003: Final Draft.* Rev. 02. February 1998. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management). WAST Project cost data has been collected by Project Work Breakdown Structure (PWBS) element (see Figure 1). The WAST life cycle costs are calculated and presented using the following cost elements:

- Waste Acceptance (WA)
- Storage
- Multi-Purpose Canister Subsystem (MPC)
- Transportation
- Project Management & Integration (PM&I)

The Transportation cost element is further broken down into National Transportation, Nevada Transportation, and Section 180(c) sub-elements.

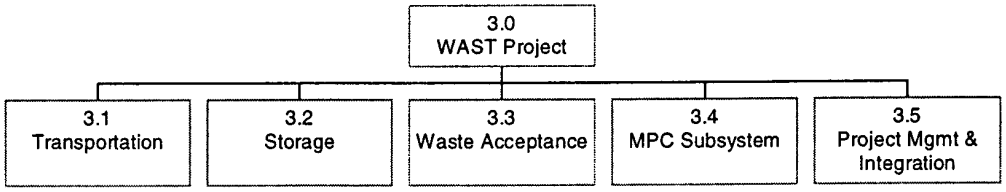

Figure 1. WAST Project Work Breakdown Structure

WAST life cycle costs are calculated for the time period 1983 to 2041 using the following phases:

Table 1. WAST Life Cycle Phases

WAST Phase	Start	End
Development & Evaluation (D&E)	1983	2005
Nevada Transportation Construction	2005	2010
Mobilization & Acquisition (M&A)	2005	2010
Acceptance, Operations & Acquisition	2010	2041

Note that the phases shown in Table 1 overlap, with 2005 and 2010 being transition years between phases.

Cost data for the time period 1983 to 1997 was obtained from historical sources. Cost data for the time period 1998 to 2003 was taken from the U.S. Department of Energy (DOE) Fiscal Year (FY) 1999 Congressional Budget Request, adjusted by the engineering judgement of the responsible managers. Cost data for the time period 2004 to 2041 was developed using a variety of sources identified in Section 3 and referenced in Section 4. Generally, for this time period, the estimates were developed for mobilization and acquisition (M&A) costs; the physical and operational characteristics of individual items (e.g., transportation casks); associated capital, maintenance, and decommissioning costs; operational activities and characteristics (e.g., loading a transportation cask and transporting it to the MGR); and the costs associated with performing individual activities.

The cost data, along with data on waste stream throughputs, are input into a computer program titled CRWMS Analysis and Logistics Visually Interactive Model (CALVIN) (CRWMS M&O 1998b). CALVIN tracks commercial SNF, DOE SNF, and high-level waste (HLW) from discharge until emplacement in the MGR, and calculates the major costs for the various activities the waste undergoes on the way. CALVIN also reports logistic information concerning CRWMS, including waste stream movement and the system resources (e. g., transportation casks, waste packages, etc.) required to perform that movement.

In addition to the output from CALVIN, supplementary calculations are performed either by hand or using Microsoft EXCEL 97 spreadsheets. These calculations include labor cost analyses for RSCs, ancillary equipment costs for Federal and Purchaser facilities, rail car and truck trailer requirements, Nevada Transportation costs, and WAST Project Support costs.

Once the principal cost elements have been calculated, contingencies are added to envelope the uncertainties in the calculations.

Finally, the total costs for each cost element are apportioned between Commercial Share and Defense Share. Those costs that cannot be directly assigned to either category (e.g., Project Support costs) are apportioned in accordance with the ratio of the Direct Transportation Costs for defense and commercial wastes.

To permit meaningful comparisons, all data have been converted to and reported in constant 1998 dollars (1998$). In addition, all costs are reported in units of millions of dollars, rounded to at most two decimal places (e.g., 45.23).

1.4 LIFE CYCLE COST REPORT OVERVIEW

This report is organized as follows:

- Section 1 provides an introduction and includes the Purpose, Scope, Responsibilities and Methodology, and this overview.
- Section 2 provides the results of the WAST LCC analysis.
- Section 3 provides the input data used in the LCC analyses, along with bases of estimate for the data.
- Section 4 provides the references used to compile this report.
- Appendix A provides a list of acronyms.
- Appendix B provides the key assumptions that serve as the basis for the LCC Report.
- Appendix C provides a comparison of the results of this analysis to the 1995 WAST LCC Report.

2. WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION LIFE CYCLE COST ANALYSIS RESULTS

Section 2 presents the summary results of the 1998 WAST LCC analysis. The summary results are presented by life cycle phase in Table 2, by cost category in Table 3, and by year in Tables 4 and 5. Figure 2 shows a graph of the life cycle cost drivers. Breakdowns of individual cost categories are included in Section 3.

Table 2. Summary WAST Life Cycle Costs by Phase (Millions of 1998$)

Cost Category[1]	WBS	Historical Cost	Base Cost	Contingency Cost	Total Cost
WAST Total	**3.0**	**$472**	**$6,070**	**$1,151**	**$7,693**
D&E Phase (1983-2005)	**3.0**	**$472**	**$85**	**$1**	**$558**
- National Transportation	3.1	$205	$57	$0	$262
- Storage (no ISF)	3.2	$202	$2	$0	$204
- Waste Acceptance	3.3	$22	$13	$1	$35
- MPC	3.4	$37	$3	$0	$40
- PM&I	3.5	$7	$10	$0	$17
M&A Phase (2005-2010)	**3.0**	**$0**	**$115**	**$25**	**$140**
- National Transportation	3.1	$0	$97	$23	$120
- Waste Acceptance	3.3	$0	$9	$1	$10
- PM&I	3.5	$0	$9	$1	$10
Operations Phase (2010-2042)	**3.0**	**$0**	**$4,973**	**$791**	**$5,764**
- National Transportation	3.1	$0	$4,908	$785	$5,693
- Waste Acceptance	3.3	$0	$65	$6	$71
Nevada Transportation		**$0**	**$504**	**$276**	**$780**
- Engineering & Construction		$0	$427	$265	$692
- Operations		$0	$77	$12	$88
Institutional [180(c)]	3.1	**$0**	**$393**	**$57**	**$450**

1 - D&E = Development & Evaluation
M&A = Mobilization & Acquisition
Note: Totals may not add up due to round-off

Table 3. Summary WAST Life Cycle Costs (Millions of 1998$)

Cost Category[1]	WAST Life Cycle Costs		
	Base Cost	Contingency	Total Cost
Waste Acceptance	**$108**	**$9**	**$116**
- D&E Phase	$34	$1	$35
- M&A Phase	$9	$1	$10
- Operations Phase	$65	$6	$71
Storage (D&E)	**$204**	**$0**	**$204**
MPC (D&E)	**$40**	**$0**	**$40**
National Transportation	**$5,267**	**$808**	**$6,075**
- D&E Phase	$262	$0	$262

- M&A Phase	$97	$23	$120
- Operations Phase	$4,909	$785	$5,693
Nevada Transportation	**$26**	**$1**	**$27**
- Construction Phase	$17	$0	$17
- Operations Phase	$9	$1	$10
PM&I	**$504**	**$276**	**$780**
- D&E Phase	$427	$265	$692
- M&A Phase	$77	$12	$88
180(c)	**$393**	**$57**	**$450**
- D&E Phase	$4	$0	$4
- M&A Phase	$37	$5	$42
- Operations Phase	$352	$51	$403
Total	**$6,542**	**$1,151**	**$7,693**

1 - D&E = Development & Evaluation
M&A = Mobilization & Acquisition
Note: Totals may not add up due to round-off

Table 4. WAST Base Costs by Year (Millions of 1998$)

Year	Waste Acceptance[1]	Storage	MPC	PM&I[2]	National Transport	Nevada Transport	180(c)	Total
1983	0.00	5.49	0.00	0.00	0.00	0.00	0.00	5.49
1984	0.00	15.03	0.00	0.00	2.22	0.00	0.00	17.25
1985	0.00	21.89	0.00	0.00	3.14	0.00	0.00	25.03
1986	0.00	12.56	0.00	0.00	8.03	0.00	0.00	20.59
1987	0.00	16.32	0.00	0.00	14.81	0.00	0.00	31.12
1988	0.00	12.29	0.00	0.00	20.47	0.00	0.00	32.77
1989	0.00	8.69	0.00	0.00	32.66	0.00	0.00	41.35
1990	0.00	15.17	0.00	0.00	26.53	0.00	0.00	41.70
1991	0.00	17.27	0.00	0.00	23.55	0.00	0.00	40.81
1992	0.00	32.29	0.00	0.00	19.37	0.00	0.00	51.65
1993	7.52	21.30	1.02	0.00	17.19	0.00	0.00	46.01
1994	4.09	5.24	12.11	0.00	16.69	0.00	0.00	26.03
1995	5.05	10.25	8.74	1.90	11.42	0.00	0.00	28.61
1996	4.37	3.46	15.10	3.76	5.90	0.00	0.00	17.49
1997	0.69	4.29	0.06	1.05	3.38	0.00	0.00	9.42
1998	0.97	1.55	0.00	1.12	2.16	0.00	1.03	6.82
1999	1.82	0.49	2.93	1.12	4.37	0.00	0.38	11.11
2000	1.42	0.00	0.00	1.09	6.16	0.00	0.38	9.04
2001	1.82	0.00	0.00	1.63	7.45	0.00	0.38	11.28
2002	1.42	0.00	0.00	1.73	17.68	15.88	0.60	37.31
2003	1.82	0.00	0.00	1.86	17.46	15.88	0.60	37.62
2004	1.42	0.00	0.00	1.85	1.30	5.39	0.80	10.76
2005	1.82	0.00	0.00	1.85	1.30	38.25	0.80	44.02
2006	2.02	0.00	0.00	1.85	1.30	152.99	8.80	166.96

Year	Waste Acceptance[1]	Storage	MPC	PM&I[2]	National Transport	Nevada Transport	180(c)	Total
2007	2.42	0.00	0.00	1.85	1.30	76.49	5.00	87.06
2008	2.02	0.00	0.00	1.85	30.87	76.49	11.00	122.23
2009	2.42	0.00	0.00	1.85	62.13	45.98	11.00	123.38
2010	2.02	0.00	0.00	0.00	130.43	2.40	11.00	145.85
2011	2.42	0.00	0.00	0.00	144.51	2.40	11.00	160.32
2012	2.02	0.00	0.00	0.00	176.42	2.40	11.00	191.84
2013	2.42	0.00	0.00	0.00	193.63	2.40	11.00	209.44
2014	2.02	0.00	0.00	0.00	197.84	2.40	11.00	213.26
2015	2.42	0.00	0.00	0.00	200.47	2.40	11.00	216.29
2016	2.02	0.00	0.00	0.00	203.50	2.40	11.00	218.92
2017	2.42	0.00	0.00	0.00	180.33	2.40	11.00	196.15
2018	2.02	0.00	0.00	0.00	183.05	2.40	11.00	198.47
2019	2.42	0.00	0.00	0.00	176.89	2.40	11.00	192.70
2020	2.02	0.00	0.00	0.00	141.80	2.40	11.00	157.22
2021	2.42	0.00	0.00	0.00	148.55	2.40	11.00	164.36
2022	2.02	0.00	0.00	0.00	141.33	2.40	11.00	156.75
2023	2.42	0.00	0.00	0.00	135.48	2.40	11.00	151.30
2024	2.02	0.00	0.00	0.00	135.15	2.40	11.00	150.57
2025	2.42	0.00	0.00	0.00	137.79	2.40	11.00	153.61
2026	2.02	0.00	0.00	0.00	131.47	2.40	11.00	146.89
2027	2.42	0.00	0.00	0.00	134.29	2.40	11.00	150.11
2028	2.02	0.00	0.00	0.00	133.86	2.40	11.00	149.28
2029	2.42	0.00	0.00	0.00	135.23	2.40	11.00	151.04
2030	2.02	0.00	0.00	0.00	134.65	2.40	11.00	150.07
2031	2.42	0.00	0.00	0.00	138.47	2.40	11.00	154.29
2032	2.02	0.00	0.00	0.00	165.99	2.40	11.00	181.41
2033	2.42	0.00	0.00	0.00	161.71	2.40	11.00	177.53
2034	2.02	0.00	0.00	0.00	156.52	2.40	11.00	171.94
2035	2.42	0.00	0.00	0.00	154.98	2.40	11.00	170.80
2036	2.02	0.00	0.00	0.00	151.17	2.40	11.00	166.59
2037	1.00	0.00	0.00	0.00	141.53	2.40	11.00	155.93
2038	1.00	0.00	0.00	0.00	135.40	2.40	11.00	149.80
2039	1.00	0.00	0.00	0.00	143.96	2.40	11.00	158.36
2040	1.00	0.00	0.00	0.00	144.23	2.40	11.00	158.63
2041	1.00	0.00	0.00	0.00	98.65	2.40	11.00	113.05
2042	0.00	0.00	0.00	0.00	19.33	0.00	0.00	19.33
Total	**107.79**	**203.57**	**39.96**	**26.37**	**5267.43**	**504.16**	**392.75**	**6542.02**

Note: Shaded areas are historical costs

1 - Waste Acceptance costs prior to 1993 are included in National Transportation

2 - PM&I costs prior to 1994 are included in National Transportation

Table 5. WAST Total Costs by Year (Millions of 1998$)

Year	Waste Acceptance[1]	Storage	MPC	PM&I[2]	National Transport	Nevada Transport	180(c)	Total
1983	0.00	5.49	0.00	0.00	0.00	0.00	0.00	5.49
1984	0.00	15.03	0.00	0.00	2.22	0.00	0.00	17.25
1985	0.00	21.89	0.00	0.00	3.14	0.00	0.00	25.03
1986	0.00	12.56	0.00	0.00	8.03	0.00	0.00	20.59
1987	0.00	16.32	0.00	0.00	14.81	0.00	0.00	31.12
1988	0.00	12.29	0.00	0.00	20.47	0.00	0.00	32.77
1989	0.00	8.69	0.00	0.00	32.66	0.00	0.00	41.35
1990	0.00	15.17	0.00	0.00	26.53	0.00	0.00	41.70
1991	0.00	17.27	0.00	0.00	23.55	0.00	0.00	40.81
1992	0.00	32.29	0.00	0.00	19.37	0.00	0.00	51.65
1993	7.52	21.30	1.02	0.00	17.19	0.00	0.00	46.01
1994	4.09	5.24	12.11	0.00	16.69	0.00	0.00	26.03
1995	5.05	10.25	8.74	1.90	11.42	0.00	0.00	28.61
1996	4.37	3.46	15.10	3.76	5.90	0.00	0.00	17.49
1997	0.69	4.29	0.06	1.05	3.38	0.00	0.00	9.42
1998	0.97	1.55	0.00	1.12	2.16	0.00	1.03	6.82
1999	2.00	0.49	2.93	1.12	4.37	0.00	0.41	11.33
2000	1.56	0.00	0.00	1.09	6.16	0.00	0.41	9.22
2001	2.00	0.00	0.00	1.63	7.45	0.00	0.41	11.49
2002	1.56	0.00	0.00	1.73	17.68	25.02	0.66	46.65
2003	2.00	0.00	0.00	1.86	17.46	25.02	0.66	47.00
2004	1.56	0.00	0.00	2.04	1.43	9.11	0.88	15.02
2005	2.00	0.00	0.00	2.04	1.43	61.99	0.88	68.34
2006	2.22	0.00	0.00	2.04	1.43	247.97	10.08	263.73
2007	2.66	0.00	0.00	2.04	1.43	123.98	5.70	135.81
2008	2.22	0.00	0.00	2.04	38.39	123.98	12.60	179.23
2009	2.66	0.00	0.00	2.04	77.47	75.08	12.60	169.85
2010	2.22	0.00	0.00	0.00	153.71	2.76	12.60	171.29
2011	2.66	0.00	0.00	0.00	170.84	2.76	12.60	188.86
2012	2.22	0.00	0.00	0.00	209.11	2.76	12.60	226.69
2013	2.66	0.00	0.00	0.00	227.27	2.76	12.60	245.29
2014	2.22	0.00	0.00	0.00	229.31	2.76	12.60	246.89
2015	2.66	0.00	0.00	0.00	232.27	2.76	12.60	250.29
2016	2.22	0.00	0.00	0.00	235.62	2.76	12.60	253.20
2017	2.66	0.00	0.00	0.00	208.09	2.76	12.60	226.11
2018	2.22	0.00	0.00	0.00	211.50	2.76	12.60	229.08
2019	2.66	0.00	0.00	0.00	203.83	2.76	12.60	221.85
2020	2.22	0.00	0.00	0.00	163.63	2.76	12.60	181.21
2021	2.66	0.00	0.00	0.00	171.46	2.76	12.60	189.48
2022	2.22	0.00	0.00	0.00	162.97	2.76	12.60	180.55
2023	2.66	0.00	0.00	0.00	155.88	2.76	12.60	173.90
2024	2.22	0.00	0.00	0.00	155.42	2.76	12.60	173.00

Year	Waste Acceptance[1]	Storage	MPC	PM&I[2]	National Transport	Nevada Transport	180(c)	Total
2025	2.66	0.00	0.00	0.00	158.48	2.76	12.60	176.50
2026	2.22	0.00	0.00	0.00	151.38	2.76	12.60	168.96
2027	2.66	0.00	0.00	0.00	154.62	2.76	12.60	172.64
2028	2.22	0.00	0.00	0.00	154.16	2.76	12.60	171.74
2029	2.66	0.00	0.00	0.00	155.70	2.76	12.60	173.72
2030	2.22	0.00	0.00	0.00	155.26	2.76	12.60	172.84
2031	2.66	0.00	0.00	0.00	159.86	2.76	12.60	177.88
2032	2.22	0.00	0.00	0.00	194.36	2.76	12.60	211.94
2033	2.66	0.00	0.00	0.00	189.60	2.76	12.60	207.62
2034	2.22	0.00	0.00	0.00	181.30	2.76	12.60	198.88
2035	2.66	0.00	0.00	0.00	179.40	2.76	12.60	197.42
2036	2.22	0.00	0.00	0.00	175.02	2.76	12.60	192.60
2037	1.10	0.00	0.00	0.00	163.86	2.76	12.60	180.32
2038	1.10	0.00	0.00	0.00	156.46	2.76	12.60	172.92
2039	1.10	0.00	0.00	0.00	167.27	2.76	12.60	183.73
2040	1.10	0.00	0.00	0.00	167.51	2.76	12.60	183.97
2041	1.10	0.00	0.00	0.00	113.98	2.76	12.60	130.44
2042	0.00	0.00	0.00	0.00	24.16	0.00	0.00	24.16
Total	**116.30**	**203.57**	**39.96**	**27.48**	**6075.48**	**780.48**	**449.52**	**7692.78**

Note: Shaded areas are historical costs
1 - Waste Acceptance costs prior to 1993 are included in National Transportation
2 - PM&I costs prior to 1994 are included in National Transportation

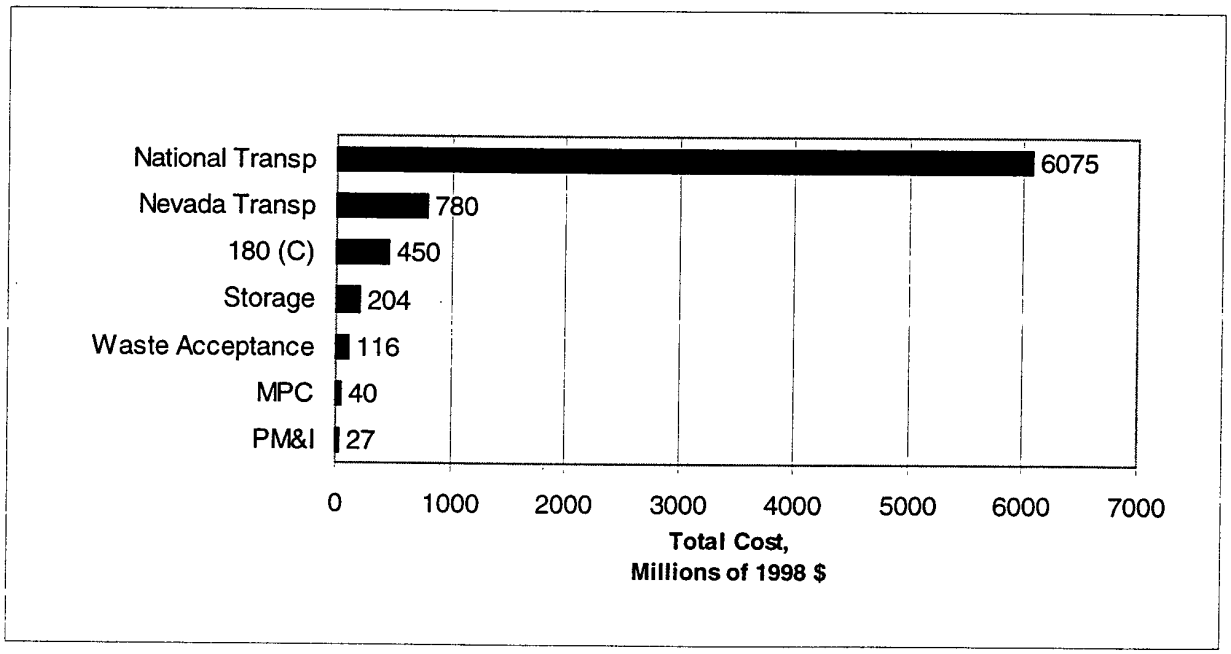

Figure 2. 1998 WAST LCC Cost Components

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3. WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION LIFE CYCLE COST BASIS OF ESTIMATE

Section 3 provides the basis of estimate (BOE) for the WAST LCC analysis. It contains the BOEs for Storage costs (Section 3.1), Transportation costs (Section 3.2), Waste Acceptance costs (Section 3.3), MPC Subsystem costs (Section 3.4) and PM&I costs (Section 3.5).

3.1 STORAGE

The current Program Approach scenario does not contain a Centralized Interim Storage Facility (CISF). WAST costs associated with Storage are those historical costs expended through FY 1997, and those FY 1998 and 1999 costs projected in the FY 1999 Congressional Budget Submittal for response to NRC comments on the CISF Topical Safety Analysis Report. Historical costs are divided into those associated with the Monitored Retrievable Storage (MRS) Facility, the CISF, and Storage Development and Evaluation (D&E) costs. These costs are summarized in Table 6 below.

Table 6. Storage Costs by Year (Millions of 1998$)

Year	MRS	CISF	Storage D&E	Total
1983	5.49	0.00	0.00	5.49
1984	15.03	0.00	0.00	15.03
1985	21.64	0.00	0.25	21.89
1986	8.25	0.00	4.31	12.56
1987	1.89	0.00	14.43	16.32
1988	1.79	0.00	10.50	12.29
1989	1.97	0.00	6.71	8.69
1990	2.59	0.00	12.58	15.17
1991	6.49	0.00	10.77	17.27
1992	24.84	0.00	7.45	32.29
1993	17.46	0.00	3.85	21.30
1994	4.07	0.00	1.17	5.24
1995	8.67	0.00	1.58	10.25
1996	0.12	2.43	0.92	3.46
1997	0.00	3.38	0.91	4.29
1998	0.00	1.55	0.00	1.55
1999 (projected)	0.00	0.49	0.00	0.49
Total	**120.30**	**7.85**	**75.43**	**203.58**

Note: Shaded area represents historical costs

3.2 TRANSPORTATION

The Transportation Element costs are divided into the following cost segments:

- National Transportation

- Nevada Transportation
- Section 180(c)

The transporting of commercial SNF is assumed to be performed by Regional Servicing Contractors (RSC). It is assumed that each of the four regions in the contiguous United States is handled by a different RSC, and that the RSCs do not share any equipment (note that DOE may actually authorize an RSC to service up to two regions). The transportation of DOE SNF and HLW is assumed to be performed separately by a single RSC.

3.2.1 Methodology

Costs for the period 1983 to 1998 are taken from historical records of program costs. Costs for the period 1999 to 2042 are derived from a variety of sources, including the DOE FY 1999 Congressional Budget Request, the Reference Transportation Data Assumptions (RTDA) document (CRWMS M&O 1995b), the WAST Cost Estimate Assumptions Document (CRWMS M&O 1998c), CALVIN computer code data files (CRWMS M&O 1998b), past experience, and engineering judgement of the responsible managers. The sources used for each cost segment are identified in the appropriate sections.

Once the principal cost elements have been calculated, contingencies are added to envelope the uncertainties in the calculations. Contingency factors for each cost segment are identified in the appropriate sections.

3.2.2 National Transportation

National transportation costs are broken down into three elements: transportation technical support costs, capital costs, and operations costs. A summary of these costs by year is presented in Tables 7 and 8 below. A breakdown of these costs elements by LCC phase (i.e., D&E, M&A, and operations) is given in the following sections. Note that the PWBS (Figure 1) includes institutional costs in national transportation. However, for this analysis, these costs are broken out and discussed in a separate section (3.2.4).

Table 7. National Transportation Base Costs by Year (Millions of 1998$)

Year	Technical Support	Capital	Operations	Total
1983	0.00	0.00	0.00	0.00
1984	2.22	0.00	0.00	2.22
1985	3.14	0.00	0.00	3.14
1986	8.03	0.00	0.00	8.03
1987	14.81	0.00	0.00	14.81
1988	20.47	0.00	0.00	20.47
1989	32.66	0.00	0.00	32.66
1990	26.53	0.00	0.00	26.53
1991	23.55	0.00	0.00	23.55
1992	19.37	0.00	0.00	19.37
1993	17.19	0.00	0.00	17.19

Year	Technical Support	Capital	Operations	Total
1994	16.69	0.00	0.00	16.69
1995	11.42	0.00	0.00	11.42
1996	5.90	0.00	0.00	5.90
1997	3.38	0.00	0.00	3.38
1998	2.16	0.00	0.00	2.16
1999	4.37	0.00	0.00	4.37
2000	6.16	0.00	0.00	6.16
2001	7.45	0.00	0.00	7.45
2002	8.68	0.00	9.00	17.68
2003	8.46	0.00	9.00	17.46
2004	1.30	0.00	0.00	1.30
2005	1.30	0.00	0.00	1.30
2006	1.30	0.00	0.00	1.30
2007	1.30	0.00	0.00	1.30
2008	1.30	29.57	0.00	30.87
2009	1.30	60.83	0.00	62.13
2010	0.00	46.76	83.68	130.43
2011	0.00	56.20	88.31	144.51
2012	0.00	71.77	104.65	176.42
2013	0.00	55.62	138.00	193.63
2014	0.00	27.51	170.33	197.84
2015	0.00	26.89	173.57	200.47
2016	0.00	25.50	178.00	203.50
2017	0.00	16.77	163.56	180.33
2018	0.00	19.47	163.58	183.05
2019	0.00	13.67	163.21	176.89
2020	0.00	5.52	136.28	141.80
2021	0.00	6.30	142.24	148.55
2022	0.00	4.42	136.90	141.33
2023	0.00	0.70	134.78	135.48
2024	0.00	0.00	135.15	135.15
2025	0.00	0.25	137.54	137.79
2026	0.00	1.89	129.58	131.47
2027	0.00	1.89	132.40	134.29
2028	0.00	2.24	131.62	133.86
2029	0.00	1.89	133.34	135.23
2030	0.00	4.12	130.52	134.65
2031	0.00	6.14	132.33	138.47
2032	0.00	34.68	131.31	165.99
2033	0.00	36.34	125.37	161.71
2034	0.00	12.98	143.55	156.52
2035	0.00	11.77	143.21	154.98
2036	0.00	11.68	139.49	151.17
2037	0.00	10.91	130.63	141.53

Year	Technical Support	Capital	Operations	Total
2038	0.00	7.60	127.80	135.40
2039	0.00	17.09	126.87	143.96
2040	0.00	16.53	127.70	144.23
2041	0.00	5.30	93.35	98.65
2042	0.00	19.33	0.00	19.33
Total	**250.42**	**670.13**	**4346.88**	**5267.43**

Table 8. National Transportation Total Costs by Year (Millions of 1998$)

Year	Technical Support	Capital	Operations	Total
1983	0.00	0.00	0.00	0.00
1984	2.22	0.00	0.00	2.22
1985	3.14	0.00	0.00	3.14
1986	8.03	0.00	0.00	8.03
1987	14.81	0.00	0.00	14.81
1988	20.47	0.00	0.00	20.47
1989	32.66	0.00	0.00	32.66
1990	26.53	0.00	0.00	26.53
1991	23.55	0.00	0.00	23.55
1992	19.37	0.00	0.00	19.37
1993	17.19	0.00	0.00	17.19
1994	16.69	0.00	0.00	16.69
1995	11.42	0.00	0.00	11.42
1996	5.90	0.00	0.00	5.90
1997	3.38	0.00	0.00	3.38
1998	2.16	0.00	0.00	2.16
1999	4.37	0.00	0.00	4.37
2000	6.16	0.00	0.00	6.16
2001	7.45	0.00	0.00	7.45
2002	8.68	0.00	9.00	17.68
2003	8.46	0.00	9.00	17.46
2004	1.43	0.00	0.00	1.43
2005	1.43	0.00	0.00	1.43
2006	1.43	0.00	0.00	1.43
2007	1.43	0.00	0.00	1.43
2008	1.43	36.96	0.00	38.39
2009	1.43	76.04	0.00	77.47
2010	0.00	58.44	95.27	153.71
2011	0.00	70.24	100.60	170.84
2012	0.00	89.72	119.39	209.11
2013	0.00	69.53	157.75	227.27
2014	0.00	34.39	194.92	229.31
2015	0.00	33.62	198.65	232.27
2016	0.00	31.87	203.74	235.62

Year	Technical Support	Capital	Operations	Total
2017	0.00	20.96	187.13	208.09
2018	0.00	24.34	187.16	211.50
2019	0.00	17.09	186.74	203.83
2020	0.00	6.91	156.72	163.63
2021	0.00	7.88	163.58	171.46
2022	0.00	5.53	157.44	162.97
2023	0.00	0.88	155.00	155.88
2024	0.00	0.00	155.42	155.42
2025	0.00	0.31	158.17	158.48
2026	0.00	2.36	149.02	151.38
2027	0.00	2.36	152.27	154.62
2028	0.00	2.80	151.37	154.16
2029	0.00	2.36	153.34	155.70
2030	0.00	5.16	150.10	155.26
2031	0.00	7.67	152.18	159.86
2032	0.00	43.35	151.01	194.36
2033	0.00	45.42	144.17	189.60
2034	0.00	16.22	165.08	181.30
2035	0.00	14.71	164.69	179.40
2036	0.00	14.60	160.42	175.02
2037	0.00	13.63	150.22	163.86
2038	0.00	9.50	146.97	156.46
2039	0.00	21.37	145.90	167.27
2040	0.00	20.66	146.85	167.51
2041	0.00	6.62	107.36	113.98
2042	0.00	24.16	0.00	24.16
Total	**251.20**	**837.66**	**4986.62**	**6075.48**

Note that "Operations" costs in Tables 7 and 8 above include both shipping costs and RSC costs. Since RSC costs (except for Phase A) include Source Selection Information (F.A.R. 3.104), they are not reported separately in this document. A discussion of RSC costs is contained in the Source Selection Sensitive version of this report (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor.).

3.2.2.1 Waste Acceptance, Storage, and Transportation Technical Support

3.2.2.1.1 Development and Evaluation Phase (1983 to 2005)

Transportation technical support for the years 1983 to 1997 are based on historical data. Transportation technical support costs for 1998 to 2003 are based on the DOE FY 1999 Congressional Budget Request. Costs for 2004 are based on past experience, the DOE FY 1999 Congressional Budget Request, and the engineering judgement of the responsible managers.

Table 9 shows the historical (1983-1997) transportation costs. Table 10 shows a breakdown of transportation technical support costs for the years 1998-2004. Costs for the transition year 2005 are included in the M&A phase (Section 3.2.1.1.2).

Table 9. 1983-1997 Transportation Costs (Millions of 1998$)

Year	Cost
1983	0.00
1984	2.22
1985	3.14
1986	8.03
1987	14.81
1988	20.47
1989	32.66
1990	26.53
1991	23.55
1992	19.37
1993	17.19
1994	16.69
1995	11.42
1996	5.90
1997	3.38
Total	205.36

Table 10. Transportation Technical Support D&E Phase Costs (Millions of 1998$)

Activity	1998	1999	2000	2001	2002	2003	2004
Transportation Technical Support – Provide technical support to RW-40 for review/evaluation of Phase A deliverables – Provide technical support to RW-40 for evaluation of Phase B/C proposals – Assist RW-40 in administration of RSC contracts – Review transportation aspects of all M&O deliverables – Provide support as required for MGR surface facility design	2.16	4.36	6.13	7.40	8.61	8.38	1.30
Total	**2.16**	**4.36**	**6.13**	**7.40**	**8.61**	**8.38**	**1.30**
Contingency	0.00	0.00	0.00	0.00	0.00	0.00	0.13
Total with Contingency	**2.16**	**4.36**	**6.13**	**7.40**	**8.61**	**8.38**	**1.43**

3.2.2.1.2 Mobilization and Acquisition Phase (2005 to 2010)

Transportation technical support costs for the years 2005 to 2009 are based on past experience, Program/Project milestones and activities described in the Strategy and Program Plan Revision 2 (DOE 1998. *OCRWM Strategy and Program Plan FY 1999 – FY 2003: Final Draft.* Rev. 02. February 1998. Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive

Waste Management), and the engineering judgement of the responsible managers. Table 11 shows a breakdown of the national transportation mobilization and acquisition phase costs for 2005-2009. Costs for the transition year 2010 are included in the RSC operations phase (see Section 3.2.2.4)

Table 11. Transportation Technical Support M&A Phase Costs (Millions of 1998$)

Activity	Cost
Transportation Technical Support – Provide technical support to RW-40 for review/evaluation of Phase A deliverables – Provide technical support to RW-40 for evaluation of Phase B/C proposals – Assist RW-40 in administration of RSC contracts – Review transportation aspects of all M&O deliverables – Provide support as required for MGR surface facility design	**1.30**
Total	**1.30**
Contingency	0.13
Total with Contingency	**1.43**

3.2.2.2 Capital Costs

3.2.2.2.1 Transportation Casks

Transportation cask unit costs include the cost of the GA-4/9 legal weight truck (LWT) cask, single-purpose rail casks (SPC), dual-purpose canister (DPC) rail casks, and HLW casks. Table 12 summarizes the unit cost for each cask, including cask purchase, basket replacement (every 25 years for SNF casks, 40 years for HLW casks), maintenance (per year), and decommissioning.

Table 12. Transportation Cask Unit Costs (Millions of 1998$)

Cask Type	Fuel Type	Capacity (Assem)	Unit Cost	Maintenance (per year)	Basket Replacement	Decommissioning
Truck						
GA-4	PWR	1-4	2.618	0.089	0.262	0.0785
GA-9	BWR	2-9	2.865	0.089	0.262	0.0860
NLI-1/2	PWR/BWR	1 / 2	2.040	0.089	0.204	0.068
Rail (SPC)						
B-Large SPC	BWR	61	4.613	0.089	0.557	0.323
P-Large SPC	PWR	26	4.613	0.089	0.466	0.323
B-Small SPC	BWR	24	3.251	0.085	0.335	0.228
P-Small SPC	PWR	12	3.251	0.085	0.343	0.228
P-ST-Sm-SPC	PWR	12	3.565	0.085	0.385	0.250
B-HH-Rail	BWR	17	4.464	0.171	0.419	0.312
P-HH- Rail	PWR	7	4.464	0.171	0.419	0.312
Rail (DPC)						

Cask Type	Fuel Type	Capacity (Assem)	Unit Cost	Maintenance (per year)	Basket Replacement	Decommissioning
B-Large DPC	BWR	61	4.194	0.089	0.557	0.294
P-Large DPC	PWR	24	4.194	0.089	0.466	0.294
B-Med-DPC	BWR	44	3.774	0.090	0.519	0.264
P-Med-DPC	PWR	21	3.774	0.090	0.436	0.264
B-Small-DPC	BWR	24	3.060	0.084	0.335	0.214
P-Small-DPC	PWR	12	3.060	0.084	0.343	0.214
P-ST-Lg-DPC	PWR	12	3.251	0.078	0.385	0.228
P-YR-Lg-DPC	PWR	36	4.194	0.089	0.466	0.294
B-BP-Lg-DPC	BWR	74	3.565	0.078	0.409	0.250
HLW Rail						
HLW-Long	HLW	5[2]	4.730	0.089	0.473	0.331
HLW-Short	HLW	5[2]	3.721	0.089	0.372	0.260
HLW-Pu	HLW	5[2]	3.721	0.089	0.372	0.260

1 - Definition of terms for Cask Types:

GA-4 = GA-4 (PWR) Legal Weight Truck Cask
GA-9 = GA-9 (BWR) Legal Weight Truck Cask
NLI-1/2 = NLI-1 (PWR) or NLI-2 (BWR) Legal Weight Truck Cask
B = BWR
P = PWR
Lg = Large
Med = Medium
Sm = Small
SPC = Single-purpose cask (for uncanistered SNF)
DPC = Dual purpose canister (for canistered SNF)
Pu = Plutonium
HH = High heat load
ST = South Texas (long PWR fuel)
YR = Yankee Rowe (non-standard size PWR fuel)
BP = Big Rock Point (non-standard size BWR fuel)
HLW = High-level waste

2 - Capacity of HLW casks is in canisters

The above costs are shown without contingency; contingencies of 25 percent (unit cost, basket replacement and decommissioning) and 15 percent (maintenance) are added for total cost calculations.

The unit cost data for the GA-4/9 were obtained from an independent cost estimate and the GA-4/9 Final Design Reports (Idaho Operations Office 1991; Idaho Operations Office 1993). The unit cost data for the HLW cask and the single-purpose SNF casks were derived using engineering judgement based on BR-100 Final Design Report (Babcock & Wilcox 1991) information obtained during the development of the MPC Conceptual Design Report (CDR) (DOE 1994). Unit costs for the DPC casks were also derived from the MPC CDR. All unit costs include the cask rail car (or trailer) and associated ancillary equipment.

Cask maintenance costs include both cask and rail car (or trailer) maintenance. Maintenance is assumed to be performed by the RSCs, except for routine incidental maintenance required at the

MGR to prepare empty casks for shipment. These incidental maintenance costs are allocated to the MGR and are not included in this report. Tractor trailer and cask rail car maintenance costs were determined from a survey of industry representatives to be approximately $10K per trailer per year and $4.7K per rail car per year (1995$). Tractor and rail engine maintenance costs are assumed to be included in the freight costs.

Decommissioning costs are assumed to be 3 percent of the truck cask unit cost and 7 percent of the rail cask unit cost, based on experienced engineering judgement.

3.2.2.2.2 Rail Cars

Two additional types of rail cars are required when transporting SNF or HLW by rail: buffer cars and personnel cars. A buffer car must be placed between the radioactive placarded cargo and any personnel traveling aboard the train, in accordance with 49 CFR 174. Therefore, a buffer car must be placed between the locomotive and the cask(s), and between the personnel car and the cask(s). It is assumed that a buffer car will be placed at each end of the cask car in a single car train, or at each end of the string of cask cars in a multiple car train (i.e., 2 buffer cars per train). In order to provide the 24-hour per day security required by 10 CFR 73 while a cask is in transit, a personnel car will be provided for each train. It is assumed that the RSC will acquire these cars (either through purchase or lease). For the purpose of this analysis, it is assumed that the cars are purchased, at the following costs (in 1998 $):

- Buffer car $50K
- Personnel car $250K

These costs were determined based on experienced engineering judgement. A 25 percent contingency is added to envelope uncertainties.

3.2.2.2.3 Site Support Equipment

The RSC will be responsible for providing site support equipment to both Purchaser/Producer sites, and to Federal facilities (i.e., the MGR). Based on experienced engineering judgement, it is estimated that the costs (in 1998 $) for this equipment will be as follows:

- Purchaser/Producer (P/P) site support equipment $300K per site
- P/P Site demos and training $50K per site
- Federal facility site support equipment $1M per RSC
- Shipping costs of equipment to Federal facility site $300K per RSC
- Demos and training $500K per RSC

The CALVIN code calculates the date of first shipment for each commercial and defense site. The Purchaser/Producer site costs are then allocated to each site in the year prior to the date of first shipment. The Federal facility site costs are allocated for each RSC (four commercial and one defense) in the year prior to commencement of operations (i.e., 2009).

Note that only the equipment costs shown above are capital costs; the other costs are included here for convenience only. A 25 percent contingency is added to equipment costs, and a 15 percent contingency to other costs.

3.2.2.3 Shipping

National Transportation shipping costs are divided into three elements: 1) legal weight truck (LWT) shipping and security costs; 2) national rail shipping and security costs; and 3) satellite tracking costs.

3.2.2.3.1 Legal Weight Truck Shipping and Security

The LWT shipping cost model is taken from the RTDA, and is based on the average tariffs provided by three different highway carriers for transporting a loaded cask to a destination, and returning the unloaded cask to the original location. Additional costs include those associated with second driver costs and demurrage. Demurrage costs are those associated with charges for drivers and equipment in use during the loading, readying, inspection, and unloading of truck transportation casks at sites and the MGR. LWT shipping costs are calculated by CALVIN for each truck shipment using the following formula:

$$LWTSC = [(\$1.161/hw + (\$0.00476/mi/hw * D) * Wl + (\$0.395/hw + \$0.00402/mi/hw * D) * We] * ESC8698$$

$$SDC = [Max(\$120 \text{ or } 2 * \$0.25/mi * D)] * ESC8698$$

$$DC = \begin{cases} 0 & T < 3 \text{ hr} \\ [\$20 * (T-3 \text{ hr})] * ESC8698 & 3 \text{ hr} < T < 24 \text{ hr} \\ [\$420 + \$25 * (T-24 \text{ hr})] * ESC8698 & T > 24 \text{ hr} \end{cases}$$

where: D = one way distance from the site to the MGR (miles)
Wl = weight of loaded transportation cask (hundreds of pounds)
We = weight of empty transportation cask (hundreds of pounds)
ESC8698 = escalation factor from 1986 dollars to 1998 dollars

Based on an RTDA analysis, per truck security costs (TSC) are determined using the following formula:

$$TSC = \$3.7 * D * ESC8698$$

3.2.2.3.2 Rail Shipping and Security

Rail shipping and security costs consist of three elements: 1) rail shipping costs; 2) barge and heavy haul costs for shipping to a nearby rail head; and 3) rail security costs.

3.2.2.3.2.1 Rail Shipping Cost

Rail shipping costs are determined by comparing the results of two different shipping cost models. The first model is taken from the RTDA, and the second from a recent survey of rail carriers (CRWMS M&O 1997. *Estimates of Railroad Charges for Shipping Spent Fuel: Draft.* E00000000-01717-5705-00001 Rev. 00. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor.).

- RTDA Model

  The RTDA model was used in the 1995 WAST LCC analysis. The costs were derived from 1986 rail tariffs for loaded ("Class 40") and unloaded ("Class 37.5") radioactive material containers in dedicated train shipments. These tariffs were then modified by a factor (9/40) to account for an Interstate Commerce Commission ruling that railroads should use a rate structure for radioactive material shipments that more closely approximates a "Class-9" tariff. The resulting round trip cost per train of n casks is assumed to be:

  $$RHC = [9/40 * (\$0.1616 * D^{0.586}) * (Wl+We) * n) + F * D] * ESC8698$$

  where:
  - D = one way distance (miles)
  - Wl = weight of loaded transportation cask (in hundreds of pounds)
  - We = weight of empty transportation cask
  - n = number of casks per train
  - F = $0 for general freight (non-dedicated) round trip shipment
    $25.62 for dedicated loaded and general freight empty haul (SNF)
    $51.23 for dedicated round trip (HLW)
  - ESC8698 = inflation factor to adjust 1986$ to 1998 $

- Updated Rail Shipping Cost Model

  The second method of calculating rail shipping costs uses updated rail cost algorithms developed from tariffs provided by four major railroad systems that service U.S. reactor sites and Caliente, NV (CRWMS M&O 1997. *Estimates of Railroad Charges for Shipping Spent Fuel: Draft.* E00000000-01717-5705-00001 Rev. 00. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor). A composite formula was developed from these individual algorithms that is representative of the total shipping costs from all reactor sites to Caliente, NV, as a function of distance shipped. The formula includes the following components:

  - Rail cask shipping charges

- Shipping charges for buffer cars, a personnel car, and six security personnel per train (not including salaries and per diem for security personnel, who are assumed to be RSC employees)

It is assumed that the RSC provides the buffer cars and personnel car.

The resulting formulas are shown below, for a round-trip shipment.

Shipment Based Cost (R1):

$$R1 = [\$0.001 * D^2 + \$7.081 * D + \$15206 + 2 * D * F] * RF * ESC9798$$

Cask Based Cost (R2):

$$R2 = [(\$0.007 * D^2 + \$17.5 * D + \$34450) * Wl/2600 * n] * RF * ESC9798$$

Total Cost: = R1 + R2

where:	D =	one way distance (miles)
	Wl =	weight of loaded transportation cask (in hundreds of pounds)
	n =	number of casks per train
	F =	\$0 for general freight (non-dedicated) shipment \$54.61 for dedicated shipment
	ESC9798 =	escalation factor from 1997 to 1998 dollars
	RF =	multiplier to reflect negotiated tariff (see below)

For this report, it is assumed that all casks are shipped in single cask shipments, using general freight tariffs (i.e., no dedicated trains).

The two models presented above result in significantly different calculated rail shipping costs, as shown below for general freight, one cask per shipment (in millions of 1998$).

- RTDA model: $312.07
- Updated model (RF=1): $1,957.18

Ultimately, the rail shipping rates for SNF and HLW shipments will be negotiated between the Office of Civilian Radioactive Waste Management (OCRWM) and the rail carriers. Until the negotiations are completed and a contract signed, the actual costs can only be estimated based on historical rates (RTDA model) and the recent input received from the rail carriers (updated model). It is assumed that the updated cost model represents an upper bound of the actual rail tariffs that would be charged by the rail carriers, and the RTDA cost model represents a lower bound. It is assumed a negotiated tariff will be somewhere in between the two rates. A multiplier (RF) is therefore included in each updated model equation above to adjust the shipping cost to reflect the cost negotiated between OCRWM and the rail carriers. For the base cost, the multiplier chosen for this report is 0.6, which represents the midpoint (rounded to one

significant figure) between 100 percent of the updated rate shown above (i.e., RF=1) and the RTDA rate . In addition, a contingency of 15 percent is added to account for the uncertainty in the cost.

3.2.2.3.2.2 Heavy-Haul and Barge Costs

Heavy-haul costs (associated with transporting SNF from a reactor site to a nearby rail head) are estimated to be ~$25K per shipment (1994$), and barge costs (from a site to a rail head) are estimated to be ~$65K per shipment (1994$). These costs are based on RTDA costs of ~$30K per day (1992$) for heavy haul, $10K per cask (1992$) for intermodal transfer costs, and ~$4.5K per day (1992$) for barge. RTDA costs were based on conversations with firms involved in heavy-haul operations.

3.2.2.3.2.3 Rail Security Costs

Two models are used for rail security costs. The first model is taken from the RTDA, and is used with the RTDA algorithm. The model assumes two security escorts will provide 24 hour surveillance while accompanying each round trip shipment and during the loading and unloading of the cask onto the train. Each escort is assumed to cost $0.19 per mile (1986 $) (charged by the carrier), and $250 per day (1986 $) for salary and per diem. The resulting formula is:

RSC = 2 * [$0.19/mile * D + $250/day * (D/(RSl * 24 hr) + D/(RSe * 24hr) + Ts)] * ESC8698

where: RSl = rail speed loaded (mph)
RSe = rail speed empty (mph)
Ts = security team waiting time (days)

The second method of calculating security costs is used with the updated rail shipping cost algorithm, and is based on the assumption that six armed escorts will provide 24 hour surveillance while accompanying each round trip shipment and during the loading and unloading of the cask onto the train (3 shifts of 2 persons). Each escort is assumed to cost $250 per day (1986$). The resulting formula is:

RSC = 6 * [$250/day * (D/(RSl * 24 hr) + D/(RSe * 24hr) + Ts)] * ESC8698

where: RSl = rail speed loaded (mph)
RSe = rail speed empty (mph)
Ts = security team waiting time (days)

3.2.2.3.3 Satellite Tracking

As part of the 24-hour per day security required for the waste shipments while in transit by truck or rail to the MGR, a satellite tracking system is assumed to be used by the carriers (RSCs). The operating costs for this system were evaluated in the RTDA, and subsequently updated to reflect more recent data. The results are detailed below:

Operating cost:	$0.055 per message (1998 $)
Message Rate:	1 message per 15 minutes

Capital costs for this system are assumed to be small (less than a few thousand dollars/year), and are therefore neglected. A 15 percent contingency is added to the operating costs to account for uncertainties.

3.2.2.4 Regional Servicing Contractor Activities

In accordance with the Competitive Private Sector Transportation Strategy, RSCs will provide waste acceptance and transportation services for commercial SNF in three contract phases. The D&E phase (Phase A) will focus on developing the detailed planning necessary for performance of the Phase B mobilization and Phase C operations activities. Phase A is assumed to begin in 2002 and last for two years. The M&A phase (Phase B) is assumed to begin in the 3rd quarter of FY 2004 and last 15.5 years, the first 5.5 of which consist of mobilization and acquisition activities associated with preparation for initial operation. The operations phase (Phase C) begins with commencement of operations in 2010, and lasts 10 years (overlapping the last 10 years of Phase B). It is assumed that RSC Phase C contracts are then continuously renewed every 10 years throughout the operations phase. A detailed description of the activities assumed to take place during these Phases is given in the draft RSC RFP (DOE 1997. *Acquisition of Waste Acceptance and Transportation Services for the Office of Civilian Radioactive Waste Management: Draft.* RFP DE-RP01-98RW00320. U.S. Department of Energy, Office of Civilian Radioactive Waste Management).

For commercial SNF, it is assumed that one RSC will service each of the four U.S. regions, with no sharing of equipment between regions. Therefore, the RSC Phase B and Phase C costs calculated below are multiplied by 4 for commercial SNF activities. It is assumed that transportation operations management activities for HLW, DOE SNF, and West Valley will be performed separately by a single RSC.

3.2.2.4.1 Development and Evaluation (Phase A)

The RSC Phase A costs assume that potential RSCs submit proposals for Phase A contracts for the servicing of all four regions at a fixed price, as provided for in the Draft RSC Request for Proposal (RFP) (DOE 1998. *Acquisition of Waste Acceptance and Transportation Services for the Office of Civilian Radioactive Waste Management: Draft.* RFP DE-RP01-98RW00320. U.S. Department of Energy, Office of Civilian Radioactive Waste Management.). Note that the Phase A duration in the draft RFP is 1 year; this has been increased to 2 years based on comments received from industry. The estimated cost for a 2-year Phase A is $9 million/year (1998$).

3.2.2.4.2 Mobilization and Acquisition (Phase B)

Key activities in Phase B include finalization of Regional Servicing Plans, acquisition of all key equipment (cask systems, ancillary cask-handling equipment, Federal facility and Purchaser site support equipment, etc.), mobilization of designated Purchaser site resources and equipment, finalization and NRC approval of routing, and establishment of logistics, security and escorts,

communications, real time tracking, and emergency response support capabilities. Additionally, Phase B activities will include planning for transportation including rail or truck carriage, heavy haul or inter-modal services, and obtaining necessary licenses, permits, authorizations, or other approvals. A discussion of the costs associated with RSC Phase B activities includes Source Selection Information (see FAR 3.104), and is contained in the Source Selection Sensitive version of this document (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor).

3.2.2.4.3 Operations (Phase C)

RSC Phase C activities include planning and acquisition activities performed during the last 10 years of Phase B, plus the transportation operations management activities required for Phase C (operations). A discussion of the costs associated with RSC Phase C activities includes Source Selection Information (see FAR 3.104), and is contained in the Source Selection Sensitive version of this document (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor).

3.2.2.4.4 Field Operations

Transportation field operations consists of those activities associated with training Federal facility and site personnel, providing technical assistance during cask loading, and performing inspections related to preparation for shipment. These activities are assumed to be performed by the RSC. Major tasks include:

- Resolution of interface problems
- Preparatory observations (related to Standard Contract requirements)
- Site personnel training
- Loading/inspection operations

Field operations costs are calculated by the CALVIN code, based on an analysis documented in the *Transportation System Data Base* document (DOE 1991). The average cost per cask (in 1990$) is as follows:

- Truck cask $6,700
- Commercial site rail cask $25,000
- HLW site rail cask $12,000

These costs were escalated to 1998 dollars for use in this analysis.

3.2.2.4.5 Regional Service Contractor Incentives and Fees

A discussion of the costs associated with RSC incentives and fees includes Source Selection Information (see FAR 3.104), and is contained in the Source Selection Sensitive version of this document (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportaiton Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor).

3.2.3 Nevada Transportation

Nevada rail transportation costs are divided into two phases: construction, and operations and maintenance (O&M). Construction costs are taken from the *Nevada Transportation Study Construction Cost Estimate* (CRWMS M&O 1997. *Nevada Transportation Study Construction Cost Estimate: Draft.* August 1997. Boise, Idaho: Morrison Knudsen.), escalated to 1998 dollars. The average cost for the five principal routes analyzed in the Study is used for the LCC. Report. Construction costs are divided into direct costs and engineering and surveying (E&S) costs. Annualized costs were developed using the Construction Cost Estimate and experienced engineering judgement. The E&S activities are assumed to begin in 2002, with construction activities (i.e., direct costs) beginning in 2004. E&S costs are allocated equally over 2002 to 2003. Other direct costs occur over the 2004 to 2009 time period. Right-of-way purchase costs and specification development costs are assumed to occur in 2004. Signaling and communications equipment purchases are assumed to occur in 2009. The remainder of the direct costs are assumed to occur over the 2005 to 2009 period, with allocation fractions of 0.1, 0.4, 0.2, 0.2, and 0.1 for each year. Construction contingencies of 20 percent for direct costs and 15 percent for E&S costs are included, in accordance with the Construction Cost Estimate. In addition, to account for uncertainties in route selection, a route contingency (equal to the standard deviation of the average construction cost for the five routes) is added to the construction contingency.

Operations and maintenance costs are taken from the *Nevada Potential Repository Preliminary Transportation Strategy Study 2* (CRWMS M&O 1996), escalated to 1998 dollars. ~~Again,~~ The average costs for the five principal routes analyzed are used. A contingency of 15 percent is added to these costs, which is consistent with other O&M costs in this report.

3.2.3.1 Construction Phase

Tables 13 through 15 show the breakdown of Nevada rail transportation construction costs used in this report. Table 13 and 14 show how the average cost and contingency are determined, and Table 15 shows the costs apportioned over the construction period.

Table 13. Nevada Rail Base Construction Costs (Millions of 1998$)

Route/Option	Caliente/ Eccles	Carlin/Big Smokey	Valley Modified	Jean/ Wilson Pass	Chalk Mtn/Orange Blossom	5 Route Average 1997$	5 Route Average 1998$
Land	4.202	6.207	1.189	2.612	2.871	3.416	3.485

Route/Option	Caliente/ Eccles	Carlin/Big Smokey	Valley Modified	Jean/ Wilson Pass	Chalk Mtn/Orange Blossom	5 Route Average 1997$	5 Route Average 1998$
Signal&Comm Eqpt	11.226	11.389	3.606	4.08	7.615	7.583	7.735
Spec Development	2.711	2.536	0.797	1.397	1.900	1.868	1.906
Other Direct	452.476	420.167	132.775	234.526	317.543	311.497	317.727
Total Direct	470.615	440.299	138.367	242.615	329.929	324.365	330.852
Contractor OH+Fee	58.302	54.262	17.147	30	40.882	40.119	40.921
Direct+OH+Fee	528.917	494.561	155.514	272.615	370.811	364.484	371.773
E&S	45.179	42.269	13.283	23.291	31.673	31.139	31.762
Construction Mgmt	33.884	31.702	9.962	17.468	23.755	23.354	23.821
Total E&S, CM	79.063	73.971	23.245	40.759	55.428	54.493	55.583
Total Base	**607.98**	**568.532**	**178.759**	**313.374**	**426.239**	**418.977**	**427.356**

Table 14. Nevada Rail Construction Contingency and Total Costs (Millions of 1998$)

	Construction Contingency, 5 Route Average (1997$)	Route Contingency (1997$)	Total Contingency (1997$)	Total Contingency (1998$)	Total Cost (1998$)
Land	0.683	1.891	2.575	2.626	6.111
Signal & Commun Equip	1.517	3.736	5.253	5.358	13.093
Spec Development	0.280	0.795	1.075	1.096	3.002
Other Direct	62.393	131.897	194.290	198.175	515.903
Total Direct	64.873	138.319	203.192	207.256	538.109
Contractor OH + Fee	8.024	17.039	25.063	25.564	66.485
Direct + OH + Fee	72.897	153.467	228.255	232.820	604.594
E&S	4.671	13.245	17.916	18.274	50.036
Construction Mgmt	3.503	9.934	13.437	13.706	37.527
Total CM, E&S	8.174	23.179	31.353	31.980	87.563
Total	**81.071**	**176.646**	**259.608**	**264.800**	**692.156**

Table 15. Nevada Rail Construction Costs by Year (Millions of 1998$)

Year	Base Cost	Contingency	Total Cost
2002	15.88	9.14	25.02
2003	15.88	9.14	25.02
2004	5.39	3.72	9.11
2005	38.25	23.74	61.99
2006	152.99	94.98	247.97
2007	76.49	47.49	123.98
2008	76.49	47.49	123.98
2009	45.98	29.10	75.08
Total	**427.36**	**264.80**	**692.16**

3.2.3.2 Operations and Maintenance

Table 16 shows the methodology and results for determining Nevada Rail Operations and Maintenance costs. As for construction costs, O&M costs are averaged over the five routes. A 15 percent contingency is added to account for uncertainties.

Table 16. Nevada Rail O&M Costs (Millions of 1998$)

Year	Calente/ Eccles	Carlin/Big Smokey	Valley Modified	Jean/ Wilson Pass	Chalk Mtn/Orange Blossom	Average (Base Cost)	Total Cost
2010	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2011	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2012	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2013	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2014	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2015	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2016	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2017	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2018	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2019	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2020	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2021	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2022	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2023	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2024	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2025	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2026	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2027	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2028	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2029	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2030	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2031	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2032	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2033	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2034	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2035	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2036	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2037	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2038	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2039	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2040	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2041	3.00	3.00	2.00	2.00	2.00	2.40	2.760
2042	0.00	0.00	0.00	0.00	0.00	0.00	0.000
Total	**96.00**	**96.00**	**64.00**	**64.00**	**64.00**	**76.80**	**88.32**

3.2.4 Section 180(c) Costs

Nuclear Waste Policy Act (NWPA) Section 180(c) costs are funds provided to State and tribal governments for training in safe routine transportation and emergency response procedures. The exact form the assistance will take has not been determined. The 180(c) costs include three components: 1) WAST institutional support costs; 2) pre-operation grants to the states/tribes prior to commencement of waste transportation; and 3) ongoing payments to states/tribes during the operations phase. It is assumed that the pre-operation grant will be made 4 years prior to operation (i.e., 2006), while the annual payments will begin 3 years prior to operation (2007).

3.2.4.1 Methodology

Costs for the period 1983 to 1997 were taken from historical records of Program costs. Costs for the period 1998 are taken from the DOE FY 1999 Congressional Budget Request. Costs for 1999 to 2041 were determined from past experience and the engineering judgement of the responsible managers.

3.2.4.2 Development and Evaluation Phase Costs

Section 180(c) costs during the D&E phase consist of WAST institutional support costs. Table 17 shows the costs for 1998 to 2004, along with a 10 percent contingency. Historical costs (1983 to 1997) are included in the Transportation D&E historical costs shown in Section 3.2.2. Costs for the transition year 2005 are included in the M&A phase (Section 3.2.4.3).

Table 17. Section 180 (c) D&E Phase Costs (Millions of 1998$)

Activity	1998	1999	2000	2001	2002	2003	2004
Institutional Support – Section 180 (c) Support – Other Institutional	1.03	0.375	0.375	0.375	0.600	0.600	0.800
Contingency	0.00	0.038	0.038	0.038	0.06	0.06	0.08
Total with Contingency	**1.03**	**0.41**	**0.41**	**0.41**	**0.66**	**0.66**	**0.88**

3.2.4.3 Mobilization and Acquisition Phase Costs

Section 180(c) costs during the M&A phase consist of: 1) WAST institutional support costs; 2) a one-time pre-operational grant to states/tribes in 2006; and 3) annual 180(c) grants to states beginning in 2007. The pre-operational grant is estimated to be $8 million. Operational grants cover state/tribal activities such as training for inspectors and state/tribal/local emergency response personnel, equipment purchases, risk assessments, and travel. The operational grants are estimated to be $4 million in 2007, and $10 million/year thereafter until the end of shipments (2041). A 15 percent contingency is added to the 180(c) grants, and a 10 percent contingency is added to WAST institutional support costs. Table 18 shows the resulting 180(c) costs for 2005-2009. Costs for the transition year 2010 are included in the operations phase (Section 3.2.4.4).

Table 18. Section 180 (c) M&A Phase Costs (Millions of 1998$)

Activity	2005	2006	2007	2008	2009
Institutional Support – Section 180 (c) Support – Other Institutional	0.800	0.800	1.00	1.00	1.00
Pre-operation grants to states/tribes	0.0	8.00	0.0	0.0	0.0
180(c) grants	0.0	0.0	4.00	10.00	10.00
Total	**0.8**	**8.80**	**5.00**	**11.00**	**11.00**
Contingency	0.08	1.28	0.70	1.60	1.60
Total with Contingency	**0.88**	**10.08**	**5.70**	**12.60**	**12.60**

3.2.4.4 Operations Phase Costs

Section 180(c) costs during the operations phase consist of: 1) WAST institutional support costs; and 2) ongoing 180(c) grants to the states/tribes. Tables 19 and 20 show the resulting base and total costs.

Table 19. Section 180 (c) Operations Phase Base Costs (Millions of 1998$)

Year	Institutional Support	180(c) Grants	Total
2010	1.00	10.00	11.00
2011	1.00	10.00	11.00
2012	1.00	10.00	11.00
2013	1.00	10.00	11.00
2014	1.00	10.00	11.00
2015	1.00	10.00	11.00
2016	1.00	10.00	11.00
2017	1.00	10.00	11.00
2018	1.00	10.00	11.00
2019	1.00	10.00	11.00
2020	1.00	10.00	11.00
2021	1.00	10.00	11.00
2022	1.00	10.00	11.00
2023	1.00	10.00	11.00
2024	1.00	10.00	11.00
2025	1.00	10.00	11.00
2026	1.00	10.00	11.00
2027	1.00	10.00	11.00
2028	1.00	10.00	11.00
2029	1.00	10.00	11.00
2030	1.00	10.00	11.00
2031	1.00	10.00	11.00
2032	1.00	10.00	11.00
2033	1.00	10.00	11.00

Year	Institutional Support	180(c) Grants	Total
2034	1.00	10.00	11.00
2035	1.00	10.00	11.00
2036	1.00	10.00	11.00
2037	1.00	10.00	11.00
2038	1.00	10.00	11.00
2039	1.00	10.00	11.00
2040	1.00	10.00	11.00
2041	1.00	10.00	11.00
2042	0.0	0.00	0.00
Total	**32.00**	**320.00**	**352.00**

Table 20. Section 180 (c) Operations Phase Total Costs (Millions of 1998$)

Year	Institutional Support	180(c) Grants	Total
2010	1.10	11.50	12.60
2011	1.10	11.50	12.60
2012	1.10	11.50	12.60
2013	1.10	11.50	12.60
2014	1.10	11.50	12.60
2015	1.10	11.50	12.60
2016	1.10	11.50	12.60
2017	1.10	11.50	12.60
2018	1.10	11.50	12.60
2019	1.10	11.50	12.60
2020	1.10	11.50	12.60
2021	1.10	11.50	12.60
2022	1.10	11.50	12.60
2023	1.10	11.50	12.60
2024	1.10	11.50	12.60
2025	1.10	11.50	12.60
2026	1.10	11.50	12.60
2027	1.10	11.50	12.60
2028	1.10	11.50	12.60
2029	1.10	11.50	12.60
2030	1.10	11.50	12.60
2031	1.10	11.50	12.60
2032	1.10	11.50	12.60
2033	1.10	11.50	12.60
2034	1.10	11.50	12.60
2035	1.10	11.50	12.60
2036	1.10	11.50	12.60
2037	1.10	11.50	12.60
2038	1.10	11.50	12.60
2039	1.10	11.50	12.60
2040	1.10	11.50	12.60

Year	Institutional Support	180(c) Grants	Total
2041	1.10	11.50	12.60
2042	1.10	0.00	0.00
Total	**36.20**	**367.00**	**403.20**

3.3 WASTE ACCEPTANCE

Waste Acceptance (WA) includes the following activities: 1) development of a process for the orderly transfer of SNF and HLW into the Federal system consistent with the needs of both the Federal Government and the owners and generators; 2) development and maintenance of a plan to carry out the Program's waste acceptance responsibilities; 3) development of a collaborative dialogue with the Nation's nuclear utility companies as well as other owners and interested stakeholders; 4) verification of the fees collected for commercial SNF; 5) maintenance and implementation of the provisions in the Standard Contract (10 CFR 961); and 6) provision of contingency planning support, studies, and analyses directed toward the competitive private sector transportation strategy. Waste acceptance costs are divided into three parts: WA D&E Phase costs (1983 - 2005); WA M&A Phase costs (2005-2010); and WA Operations Phase costs (2010 - 2041). A summary of the WA costs is presented in Tables 21 and 22, below.

Table 21. Waste Acceptance Base Costs by Year (Millions of 1998$)

Year	WA D&E	WA M&A	WA Operations	Total WA
1993	7.52	0.00	0.00	7.52
1994	4.09	0.00	0.00	4.09
1995	5.05	0.00	0.00	5.05
1996	4.37	0.00	0.00	4.37
1997	0.69	0.00	0.00	0.69
1998	0.97	0.00	0.00	0.97
1999	1.82	0.00	0.00	1.82
2000	1.42	0.00	0.00	1.42
2001	1.82	0.00	0.00	1.82
2002	1.42	0.00	0.00	1.42
2003	1.82	0.00	0.00	1.82
2004	1.42	0.00	0.00	1.42
2005	1.82	0.00	0.00	1.82
2006	0.00	2.02	0.00	2.02
2007	0.00	2.42	0.00	2.42
2008	0.00	2.02	0.00	2.02
2009	0.00	2.42	0.00	2.42
2010	0.00	0.00	2.02	2.02
2011	0.00	0.00	2.42	2.42
2012	0.00	0.00	2.02	2.02
2013	0.00	0.00	2.42	2.42
2014	0.00	0.00	2.02	2.02
2015	0.00	0.00	2.42	2.42

Year	WA D&E	WA M&A	WA Operations	Total WA
2016	0.00	0.00	2.02	2.02
2017	0.00	0.00	2.42	2.42
2018	0.00	0.00	2.02	2.02
2019	0.00	0.00	2.42	2.42
2020	0.00	0.00	2.02	2.02
2021	0.00	0.00	2.42	2.42
2022	0.00	0.00	2.02	2.02
2023	0.00	0.00	2.42	2.42
2024	0.00	0.00	2.02	2.02
2025	0.00	0.00	2.42	2.42
2026	0.00	0.00	2.02	2.02
2027	0.00	0.00	2.42	2.42
2028	0.00	0.00	2.02	2.02
2029	0.00	0.00	2.42	2.42
2030	0.00	0.00	2.02	2.02
2031	0.00	0.00	2.42	2.42
2032	0.00	0.00	2.02	2.02
2033	0.00	0.00	2.42	2.42
2034	0.00	0.00	2.02	2.02
2035	0.00	0.00	2.42	2.42
2036	0.00	0.00	2.02	2.02
2037	0.00	0.00	1.00	1.00
2038	0.00	0.00	1.00	1.00
2039	0.00	0.00	1.00	1.00
2040	0.00	0.00	1.00	1.00
2041	0.00	0.00	1.00	1.00
2042	0.00	0.00	0.00	0.00
Total	**34.23**	**8.87**	**64.69**	**107.79**

Note: Shaded area represents historical costs

Table 22. Waste Acceptance Total Costs by Year (Millions of 1998$)

Year	WA D&E	WA M&A	WA Operations	Total WA
1993	7.52	0.00	0.00	7.52
1994	4.09	0.00	0.00	4.09
1995	5.05	0.00	0.00	5.05
1996	4.37	0.00	0.00	4.37
1997	0.69	0.00	0.00	0.69
1998	0.97	0.00	0.00	0.97
1999	2.00	0.00	0.00	2.00
2000	1.56	0.00	0.00	1.56
2001	2.00	0.00	0.00	2.00
2002	1.56	0.00	0.00	1.56
2003	2.00	0.00	0.00	2.00
2004	1.56	0.00	0.00	1.56

Year	WA D&E	WA M&A	WA Operations	Total WA
2005	2.00	0.00	0.00	2.00
2006	0.00	2.22	0.00	2.22
2007	0.00	2.66	0.00	2.66
2008	0.00	2.22	0.00	2.22
2009	0.00	2.66	0.00	2.66
2010	0.00	0.00	2.22	2.22
2011	0.00	0.00	2.66	2.66
2012	0.00	0.00	2.22	2.22
2013	0.00	0.00	2.66	2.66
2014	0.00	0.00	2.22	2.22
2015	0.00	0.00	2.66	2.66
2016	0.00	0.00	2.22	2.22
2017	0.00	0.00	2.66	2.66
2018	0.00	0.00	2.22	2.22
2019	0.00	0.00	2.66	2.66
2020	0.00	0.00	2.22	2.22
2021	0.00	0.00	2.66	2.66
2022	0.00	0.00	2.22	2.22
2023	0.00	0.00	2.66	2.66
2024	0.00	0.00	2.22	2.22
2025	0.00	0.00	2.66	2.66
2026	0.00	0.00	2.22	2.22
2027	0.00	0.00	2.66	2.66
2028	0.00	0.00	2.22	2.22
2029	0.00	0.00	2.66	2.66
2030	0.00	0.00	2.22	2.22
2031	0.00	0.00	2.66	2.66
2032	0.00	0.00	2.22	2.22
2033	0.00	0.00	2.66	2.66
2034	0.00	0.00	2.22	2.22
2035	0.00	0.00	2.66	2.66
2036	0.00	0.00	2.22	2.22
2037	0.00	0.00	1.10	1.10
2038	0.00	0.00	1.10	1.10
2039	0.00	0.00	1.10	1.10
2040	0.00	0.00	1.10	1.10
2041	0.00	0.00	1.10	1.10
2042	0.00	0.00	0.00	0.00
Total	**33.38**	**11.76**	**71.16**	**116.30**

3.3.1 Methodology

Costs for the period 1983 to 1997 were taken from historical records of Program costs. Note that prior to 1993, waste acceptance costs were included in transportation D&E (see Section 3.2.2.1). Costs for the period 1998 are taken from the DOE FY 1999 Congressional Budget Request.

Costs for 1999 to 2041 were determined from past experience and the engineering judgement of the responsible managers. A 10 percent contingency is included in the costs from 1999 to 2041, consistent with costing guidelines, to reflect uncertainties associated with costed activities.

3.3.2 Waste Acceptance Development and Evaluation Costs

The WA D&E period is assumed to last from 1982 to 2005. Costs for 1983 to 1997 period reflect historic costs, as discussed above. Costs for the period 1998 are taken from the DOE FY 1999 Congressional Budget Request. Costs for the 1999 to 2005 time period were developed by evaluating the specific annual tasks required to support the WA activities listed in Section 3.3. Table 23 lists the WA tasks and assigned costs for WA D&E. Costs for the transition year 2005 are included in the D&E phase.

Table 23. Waste Acceptance D&E Phase Cost Breakdown (Millions of 1998$)

Activity	1999	2000	2001	2002	2003	2004	2005
MC&A Implementation	0.150	0.150	0.150	0.150	0.150	0.150	0.150
– Verification Requirements	0.050	0.050	0.050	0.050	0.050	0.050	0.050
– Hardware/Software Develop/Maint	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Contract/MOA Maintenance	1.47	1.070	1.47	1.070	1.47	1.070	1.47
– Data Collection (DOE)	0.000	0.050	0.000	0.050	0.000	0.050	0.000
– Data Validation/Dissemination	0.100	0.050	0.100	0.050	0.100	0.050	0.100
– Waste Inventory Tracking	0.050	0.050	0.050	0.050	0.050	0.050	0.050
– Forecasting/Planning Support	0.250	0.250	0.250	0.250	0.250	0.250	0.250
– Litigation Support	0.100	0.100	0.100	0.100	0.100	0.100	0.100
– Fee Validation/Revenue Projections (EIA)	0.270	0.270	0.270	0.270	0.270	0.270	0.270
– Data Collection (RW-859) (EIA/M&O)	0.330	0.000	0.330	0.000	0.330	0.000	0.330
– APR/ACR Development	0.070	0.000	0.070	0.000	0.070	0.000	0.070
– MOA/TSLCC/Fee Support	0.300	0.000	0.300	0.000	0.300	0.000	0.300
Scheduling/Queuing Waste Receipts	0.200	0.200	0.200	0.200	0.200	0.200	0.200
– DCS/FDS System Development	0.100	0.100	0.100	0.100	0.100	0.100	0.100
– Purchaser/Custodian Interface	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Total	**1.82**	**1.42**	**1.82**	**1.42**	**1.82**	**1.42**	**1.82**
Contingency	0.18	0.14	0.18	0.14	0.18	0.14	0.18
Total With Contingency	**2.00**	**1.56**	**2.00**	**1.56**	**2.00**	**1.56**	**2.00**

3.3.3 Waste Acceptance Mobilization and Acquisition Costs

The WA M&A period is assumed to last from 2005 to 2010. Costs for this time period were developed by evaluating the specific annual tasks required to support the WA activities listed in Section 3.3. Note that the year 2009 costs are the same as for the "Operations" period shown in Section 3.3.4, below. This reflects the shift from a pre-operations mode to an operations mode in 2009. Table 24 lists the WA tasks and assigned costs for 2006-2009 (2005 costs are included in the D&E phase). Costs for the transition year 2010 are included in the operations phase (Section 3.3.4).

Table 24. Waste Acceptance M&A Phase Cost Breakdown (Millions of 1998$)

Activity	2006	2007	2008	2009
MC&A Implementation	0.450	0.450	0.450	0.600
– Verification Requirements	0.050	0.050	0.050	0.050
– Hardware/Software Develop/Maint	0.050	0.050	0.050	0.050
– System Security Controls	0.050	0.050	0.050	0.050
– Training	0.300	0.300	0.300	0.200
– Data Collection/Verification	0.000	0.000	0.000	0.100
– Data Processing	0.000	0.000	0.000	0.050
– Inventory Tracking/Reporting	0.000	0.000	0.000	0.100
Contract/MOA Maintenance	0.970	1.370	0.970	1.220
– Data Collection (DOE)	0.050	0.000	0.050	0.000
– Data Validation/Dissemination	0.050	0.100	0.050	0.100
– Waste Inventory Tracking	0.050	0.050	0.050	0.050
– Forecasting/Planning Support	0.250	0.250	0.250	0.200
– Litigation Support	0.100	0.100	0.100	0.100
– Fee Validation/Revenue Projections (EIA)	0.270	0.270	0.270	0.270
– Data Collection (RW-859) (EIA/M&O)	0.000	0.330	0.000	0.330
– APR/ACR Development	0.000	0.070	0.000	0.070
– MOA/TSLCC/Fee Support	0.200	0.200	0.200	0.100
Scheduling/Queuing Waste Receipts	0.600	0.600	0.600	0.600
– DCS/FDS System Development	0.200	0.200	0.200	0.200
– Purchaser/Custodian Interface	0.200	0.200	0.200	0.200
– RSC Integration	0.200	0.200	0.200	0.200
Total	**2.02**	**2.42**	**2.02**	**2.42**
Contingency	0.20	0.24	0.20	0.24
Total With Contingency	**2.22**	**2.66**	**2.22**	**2.66**

3.3.4 Waste Acceptance Operations Costs

The WA Operations Phase is assumed to last from 2010 to 2041. Costs for the Operations period were developed by evaluating the specific annual tasks required to support the WA operations – related activities listed in Section 3.3. Table 25 lists the WA tasks and assigned costs for WA D&E.

Table 25. Waste Acceptance Operations Phase Costs (Millions of 1998$)

Activity	2010 – 2036		2037-2041
	Even Years	Odd Years	
MC&A Implementation	0.600	0.600	0.450
– Verification Requirements	0.050	0.050	0.050
– Hardware/Software Develop/Maint.	0.050	0.050	0.050
– System Security Controls	0.050	0.050	0.050
– Training	0.200	0.200	0.050
– Data Collection/Verification	0.100	0.100	0.100

– Data Processing	0.050	0.050	0.050
– Inventory Tracking/Reporting	0.100	0.100	0.100
Contract/MOA Maintenance	0.820	1.220	0.250
– Data Collection (DOE)	0.050	0.000	0.000
– Data Validation/Dissemination	0.050	0.100	0.050
– Waste Inventory Tracking	0.050	0.050	0.050
– Forecasting/Planning Support	0.200	0.200	0.050
– Litigation Support	0.100	0.100	0.050
– Fee Validation/Revenue Projections (EIA)	0.270	0.270	0.050
– Data Collection (RW-859) (EIA/M&O)	0.000	0.330	0.000
– APR/ACR Development	0.000	0.070	0.000
– MOA/TSLCC/Fee Support	0.100	0.100	0.000
Scheduling/Queuing Waste Receipts	0.600	0.600	0.300
– DCS/FDS System Development	0.200	0.200	0.100
– Purchaser/Custodian Interface	0.200	0.200	0.100
– RSC Integration	0.200	0.200	0.100
Total	**2.02**	**2.42**	**1.00**
Contingency	0.20	0.24	0.10
Total With Contingency	**2.22**	**2.66**	**1.10**

3.4 MULTI-PURPOSE CANISTER SUBSYSTEM

The current Program Approach scenario as reflected in the 1999 DOE Congressional Budget Request does not contain provisions for OCRWM funding for development of the MPC subsystem. The FY 1999 Congressional Budget Request includes $3 million in FY 1999 to "provide the private sector an incentive to stimulate the development and implementation of a MPC system compatible with repository disposal requirements". WAST life cycle costs associated with the MPC are therefore those historical costs expended through FY 1997, plus the FY 1999 projected expenditure. These costs are shown in Table 26, below.

Table 26. MPC Subsystem Costs by Year

Year	Cost (Millions of 1998$)[1]
1993	1.02
1994	12.11
1995	8.74
1996	15.10
1997	0.06
1998	0.00
1999	2.93
Total	39.96

1 – Shaded area represents historical costs

3.5 WASTE ACCEPTANCE, STORAGE AND TRANSPORTATION PROJECT MANAGEMENT AND INTEGRATION

WAST PM&I consists of activities and tasks that support each of the product areas for the WAST Project. Specifically, the PM&I area includes project management, project control, and technical and programmatic integration of tasks and activities across the Project. The integration tasks include project integration, systems engineering, environmental safety and health, National Environmental Policy Act (NEPA) compliance, and quality compliance. These activities are associated with the WAST Project as a whole. Once all of the WAST Configuration Items (CI) are operational (i.e., in 2010), these functions will become part of the Waste Acceptance Operations function currently allocated to WA (see Section 3.3).

For the period 1983 to 1994, WAST PM&I costs were collected and reported as part of the Storage (MRS) costs (see Section 3.1). For the period 1995 to 1997, costs were extracted from historical data. For the period 1998 to 2003, costs were taken from the DOE FY 1999 Congressional Budget Request For the period from 2004 to 2009, costs were estimated based on FY 2003 costs, and continuing PM&I activities identified in the DOE FY 1999 Congressional Budget Request. The bases for these costs are 1998 costs, past experience, and the engineering judgement of the responsible managers. A 10 percent contingency has been added to the costs from 2004 to 2009, consistent with costing guidelines, to reflect uncertainties associated with costed activities. Note that costs for the transition year 2005 are included in the M&A phase.

Tables 27 and 28 summarize the WAST PM&I costs for the D&E and M&A phases by year.

Table 27. Summary WAST PM&I Base Costs (Millions of 1998$)

Year	D&E	M&A	Total
1995	1.90	0.00	1.90
1996	3.76	0.00	3.76
1997	1.05	0.00	1.05
1998	1.12	0.00	1.12
1999	1.12	0.00	1.12
2000	1.09	0.00	1.09
2001	1.63	0.00	1.63
2002	1.73	0.00	1.73
2003	1.86	0.00	1.86
2004	1.85	0.00	1.85
2005	0.00	1.85	1.85
2006	0.00	1.85	1.85
2007	0.00	1.85	1.85
2008	0.00	1.85	1.85
2009	0.00	1.85	1.85
Total	**17.12**	**9.25**	**26.37**

Table 28. Summary PM&I Total Costs (Millions of 1998$)

Year	D&E	M&A	Total
1995	1.90	0.00	1.90
1996	3.76	0.00	3.76
1997	1.05	0.00	1.05
1998	1.12	0.00	1.12
1999	1.12	0.00	1.12
2000	1.09	0.00	1.09
2001	1.63	0.00	1.63
2002	1.73	0.00	1.73
2003	1.86	0.00	1.86
2004	2.04	0.00	2.04
2005	0.00	2.04	2.04
2006	0.00	2.04	2.04
2007	0.00	2.04	2.04
2008	0.00	2.04	2.04
2009	0.00	2.04	2.04
Total	**17.30**	**10.18**	**27.48**

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10 CFR 73. Energy: Physical Protection of Plants and Materials.

10 CFR 961. Energy: Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste.

APPENDIX A

ACRONYMS

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ACRONYMS

A

ACR	Acceptance Capacity Report

B

BOE	Basis of Estimate

C

CALVIN	CRWMS Analysis and Logistics Visually Interactive Model
CDR	Conceptual Design Report
CISF	Centralized Interim Storage Facility
CRD	CRWMS Requirements Document
CRWMS	Civilian Radioactive Waste Management System

D

D&E	Development and Evaluation
DOE	U.S. Department of Energy
DPC	Dual-Purpose Canister

E

E&S	Engineering and Surveillance
EIA	Energy Information Administration

F

FY	Fiscal Year

H

HLW	High Level Waste

L

LCC	Life Cycle Cost
LWT	Legal Weight Truck

M

M&A	Mobilization and Acquisition
MGR	Monitored Geologic Repository

MPC	Multi-Purpose Canister
MRS	Monitored Retrievable Storage
MTHM	Metric Tons of Heavy Metal
MTU	Metric Tons of Uranium

N

NEPA	National Environmental Policy Act
NWPA	Nuclear Waste Policy Act

O

O&M	Operations and Maintenance
OCRWM	Office of Civilian Radioactive Waste Management

P

PM&I	Project Management and Integration
PWBS	Project Work Breakdown Structure

R

RFP	Request for Proposal
RSC	Regional Servicing Contractor
RTDA	Reference Transportation Data Assumptions

S

SNF	Spent Nuclear Fuel

T

TSLCC	Total System Life Cycle Cost

W

WA	Waste Acceptance
WAST	Waste Acceptance, Storage, and Transportation

APPENDIX B

WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION COST ESTIMATE KEY ASSUMPTIONS

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WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION COST ESTIMATE KEY ASSUMPTIONS

The following key assumptions are taken from the *WAST Cost Estimate Assumptions Document* (CRWMS M&O 1998c).

A. All nuclear material will be shipped directly to the carrier/cask shipping and receiving facilities at the MGR.

B. Commercial SNF will be transported from Purchaser sites by rail, except for 11 facilities, which will utilize legal weight truck transportation casks. (Recent information has reduced this from 13 facilities.) Yankee Rowe and Big Rock Point facilities have announced the use of large rail DPCs for dry storage and transportation.

C. Up to four RSCs will plan and operate the entire transportation system including cask maintenance. The contiguous United States is assumed to be comprised of four independent regions with no shared resources (e.g., transportation casks, and cask maintenance facilities).

D. The initial RSC contracts will have three phases:

- Phase A is for 2 years of planning activities, followed by a 6-month DOE source selection process.
- Phase B is for 5.5 years of startup activities, followed by 10 years of equipment acquisition, concurrent with Phase C.
- Phase C is a 10-year operations period followed by succeeding 10-year operating periods.

E. Transportation casks are re-usable with refurbishment and basket replacement (for uncanistered fuel casks) performed every 25 years. Nuclear Regulatory Commission re-certification is required every 5 years.

F. A branch rail line will be built, connecting the MGR with a main rail line. Since no specific rail routing has been determined, the estimated cost will be the average cost of the five studied route options.

G. Rail transportation of commercial SNF is assumed to be performed by general freight rather than dedicated trains.

H. An updated rail algorithm, based upon the *Estimates of Railroad Charges for Shipping Spent Fuel* (CRWMS M&O 1997. *Estimates of Railroad Charges for Shipping Spent Fuel: Draft.* E00000000-01717-5705-00001 Rev. 00. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor.) for determining rail transport costs will be used instead of the previous algorithm used from the September 25, 1995 *Reference Transportation Data and Assumptions Report* (CRWMS M&O 1995b). The

algorithm will assume adjustment factors for shipping weight and a rate negotiation factor of 0.6.

I. Commercial SNF will be placed in the queue for pickup by Oldest Fuel First/Annual Priority Ranking. The Oldest Fuel First/Annual Priority Ranking process identifies the sites and quantities to be accepted. Upon site designation, the individual fuel assemblies to be picked up are determined using a Youngest Fuel First greater or equal to 10-years old fuel basis. The rate of acceptance is shown in Table B-1.

J. All Purchasers with the capability to handle rail transportation casks (this includes two former truck facilities - Yankee Rowe and Big Rock Point) are assumed to use canisters designed for dry storage and transportation only (DPCs) for onsite dry storage. Additionally, the Purchasers are assumed to empty the spent fuel pools into dry storage DPCs 5 years after the last reactor discharge on site (see Table B-2).

Table B-1. Commercial SNF Acceptance Rates

Year	Acceptance Rate (MTHM/year)
1999 – 2009	0
2010	400
2011	600
2012	1,200
2013	2,000
2014	3,000
2015 – 2040	3,000
2041	1,117
Total	86,317

Data Source: CRWMS Requirements Document (CRD) Revision 4 (CRWMS M&O 1998a).

Table B-2. Assumed (or Actual) Reactor Shutdown Schedule as of 12/97

Site	Pool 1	Pool 2	Pool 3	Last Discharge Date
HUMBOLDT BAY	1976			1976
LACROSSE	1987			1987
RANCHO SECO	1989			1989
YANKEE-ROWE	1991			1991
TROJAN	1992			1992
HADDAM NECK	1996			1996
BIG ROCK POINT	1997			1997
MAINE YANKEE	1997			1997
ZION (as of 12/97)	2005			2005

Site	Pool 1	Pool 2	Pool 3	Last Discharge Date
PALISADES	2007			2007
GINNA	2009			2009
OYSTER CREEK	2009			2009
MONTICELLO	2010			2010
ROBINSON	2010			2010
DRESDEN	1978	2006	2011	2011
PILGRIM	2012			2012
QUAD CITIES *	2012			2012
VERMONT YANKEE	2012			2012
INDIAN POINT 1&2	1974	2013		2013
SAN ONOFRE	1992	2013	2013	2013
FORT CALHOUN	2013			2013
KEWAUNEE	2013			2013
POINT BEACH	2013			2013
SURRY	2013			2013
TURKEY POINT	2012	2013		2013
COOPER STATION	2014			2014
DUANE ARNOLD	2014			2014
FITZPATRICK	2014			2014
OCONEE	2013	2014		2014
PEACH BOTTOM	2013	2014		2014
PRAIRIE ISLAND	2014			2014
THREE MILE ISLAND	2014			2014
INDIAN POINT 3	2015			2015
BROWNS FERRY*	2014	2016		2016
BRUNSWICK	2014	2016		2016
CALVERT CLIFF *	2016			2016
CRYSTAL RIVER	2016			2016
COOK	2017			2017
DAVIS-BESSE	2017			2017
ARKANSAS NUCLEAR	2014	2018		2018
HATCH *	2018			2018
NORTH ANNA	2020			2020
SALEM	2016	2020		2020
FARLEY	2017	2021		2021
SEQUOYAH	2021			2021
GRAND GULF	2022			2022
SUMMER	2022			2022
SAINT LUCIE	2016	2023		2023
MCGUIRE	2021	2023		2023
LASALLE *	2023			2023
WASHINGTON NUCLEAR	2023			2023
CALLAWAY	2024			2024
SUSQUEHANNA *	2024			2024

Site	Pool 1	Pool 2	Pool 3	Last Discharge Date
WATERFORD	2024			2024
MILLSTONE	2010	2015	2025	2025
DIABLO CANYON	2021	2025		2025
ENRICO FERMI	2025			2025
RIVER BEND	2025			2025
WOLF CREEK	2025			2025
NINE MILE POINT	2009	2026		2026
CATAWBA	2024	2026		2026
HARRIS	2026			2026
BYRON	2026			2026
CLINTON	2026			2026
HOPE CREEK	2026			2026
PERRY	2026			2026
SEABROOK	2026			2026
BEAVER VALLEY	2016	2027		2027
PALO VERDE	2024	2025	2027	2027
BRAIDWOOD	2027			2027
SOUTH TEXAS	2027	2028		2028
LIMERICK*	2029			2029
VOGTLE*	2029			2029
COMANCHE PEAK*	2033			2033
WATTS BAR	2036			2036

*These sites have two pools which are connected with a transfer canal, therefore they are treated as one pool for planning purposes.

Data source: Energy Information Administration (EIA) Service Report

APPENDIX C

COMPARISON TO 1995 WASTE ACCEPTANCE, STORAGE, AND TRANSPORTATION LIFE CYCLE COST REPORT

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C.1 SUMMARY

This appendix compares the WAST LCC generated for this report with the costs reported in the *1995 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report* (CRWMS M&O 1995c). In order to compare like costs, the D&E and M&A phases for the 1998 WAST costs were combined. Tables C-1 and C-2 show a summary comparison of life cycle base costs and costs with contingency, respectively. Note that MPC and Nevada transportation costs are separated out in Tables C-1 and C-2. This is because the differences between 1998 and 1995 costs for these elements are principally due to project scope changes: Nevada transportation costs in the 1995 TSLCC analysis were allocated to the MGDS (now MGR) project; and the MPC was eliminated from WAST scope after 1995 (resulting in offsetting MGR costs for additional waste packages). Therefore, a comparison without these two elements shows the effect of model, data, and assumptions changes. Table C-3 shows a comparison of annualized costs.

Table C-1. 1998 – 1995 WAST Life Cycle Base Cost Comparison

Cost Category	WAST Life Cycle Costs (Millions of 1998$)		
	1998	1995	1998 - 1995
Waste Acceptance	**$108**	**$1,343**	**($1,235)**
- D&E [1]	$33	$88	($45)
- Operations	$65	$1,255	($1190)
Storage (All D&E)	**$204**	**$263**	**($59)**
National Transportation	**$5,267**	**$2,256**	**$3,011**
- D&E [1]	$359	$384	$(25)
- Operations	$4,909	$1,872	$3,037
180 (c)	$393	$382	$11
- D&E [1]	$41	$8	$33
- Operations	$352	$374	($22)
PM&I	**$26**	**$204**	**($178)**
Subtotal	**$5,998**	**$4,448**	**$1,550**
MPC Subsystem	**$40**	**$5,043**	**($5003)**
- D&E [1]	40	$155	($115)
- Operations	0	$4888	($4888)
Nevada Transportation	**$504**	**N/I**	**$504**
- Construction	$427	N/I	$427
- Operations	$77	N/I	$77
Total	**$6,542**	**$9,491**	**($3,049)**

1 - "D&E" costs for 1998 WAST Costs include both D&E and M&A phases
N/I = Not included

Table C-2. 1998 – 1995 WAST Life Cycle Total Cost Comparison

Cost Category	WAST Life Cycle Costs (Millions of 1998$)		
	1998	1995	1998 - 1995
Waste Acceptance	**$116**	**$1,469**	**($1,353)**
- D&E [1]	$45	$94	($38)
- Operations	$71	$1,376	($1,305)
Storage (All D&E)	**$204**	**$268**	**($64)**
National Transportation	$6,075	$2,483	$3,592
- D&E [1]	$382	$344	$38
- Operations	$5,693	$2,139	$3,554
180 (c)	**$450**	**$445**	**$5**
- D&E [1]	$46	$63	($17)
- Operations	$403	$382	$21
PM&I (all D&E)[1]	**$27**	**$220**	**($193)**
Subtotal	**$6,872**	**$4,887**	**$1,985**
MPC Subsystem	**$40**	**$6,232**	**($6,192)**
- D&E	$40	$155	($115)
- Operations	$0	$6,077	($6,077)
Nevada Transportation	**$780**	**N/I**	**$780**
- Construction	$692	N/I	$692
- Operations	$88	N/I	$88
Total	**$7,693**	**$11,117**	**($3,424)**

1 - "D&E" costs for 1998 WAST Costs include both D&E and M&A phases
N/I = Not included

Table C-3. 1998 – 1995 WAST Life Cycle Annualized Cost Comparison (Millions of 1998$)

Year	Total Costs	
	1998	1995
1983	5.49	5.51
1984	17.25	17.07
1985	25.03	24.88
1986	20.59	20.48
1987	31.12	30.94
1988	32.77	32.59
1989	41.35	41.07
1990	41.70	41.40
1991	40.81	40.63
1992	51.65	51.64
1993	46.01	47.01
1994	26.03	38.20
1995	28.61	60.44
1996	17.49	65.07

Year	Total Costs	
	1998	1995
1997	9.42	70.24
1998	6.82	83.68
1999	11.33	88.19
2000	9.22	90.72
2001	11.49	159.98
2002	46.65	117.37
2003	47.00	107.13
2004	15.02	114.17
2005	68.34	115.49
2006	263.73	116.27
2007	135.81	175.72
2008	179.23	157.88
2009	169.85	224.82
2010	171.29	279.65
2011	188.86	358.60
2012	226.69	379.29
2013	245.29	360.03
2014	246.89	379.85
2015	250.29	369.39
2016	253.20	329.42
2017	226.11	325.02
2018	229.08	328.87
2019	221.85	322.48
2020	181.21	326.67
2021	189.48	328.54
2022	180.55	324.13
2023	173.90	333.38
2024	173.00	331.07
2025	176.50	334.04
2026	168.96	339.00
2027	172.64	336.69
2028	171.74	331.18
2029	173.72	345.27
2030	172.84	345.16
2031	177.88	337.68
2032	211.94	352.98
2033	207.62	358.27
2034	198.88	197.30
2035	197.42	124.96
2036	192.60	102.61
2037	180.32	113.07
2038	172.92	91.27
2039	183.73	82.69
2040	183.97	50.21

Year	Total Costs	
	1998	1995
2041	130.44	55.49[1]
2042	24.16	0.00
Total	**7692.78**	**11,112.85[2]**

1 - Labeled as "2041 - 2071" costs in 1995 WAST LCC Report
2 - Total does not match Table C-2 total due to round off

C.2 IMPACTS OF MAJOR CHANGES SINCE 1995

This section compares the cost impacts of major changes in models, assumptions or parameters since the 1995 WAST LCC Report. Note that these impacts in general are not additive, since most of them are not independent. For example, the cost differences due to the revised waste stream depends on the shipping cost algorithm and the cask fleet unit costs.

C.2.1 Waste Stream

The waste stream for the 1995 WAST LCC Report included 83,954 metric tons of uranium (MTU) of commercial SNF and 18,346 canisters of HLW; no DOE SNF or plutonium wastes forms were included. The 1998 waste stream consists of 86,300 metric tons of heavy metal (MTHM) of CNSF, 2750 MTHM of DOE SNF (including 63 MTHM of naval SNF), and 20,029 canisters of HLW (including 635 containing immobilized plutonium). To evaluate the effect of the change in waste stream on WAST LCCs, a CALVIN run was made using 1998 WAST LCC assumptions, except that the 1995 waste stream was used. The resulting costs (not including Nevada Transportation) are shown by waste type in Tables C-4 and C-5, below.

Table C-4. 1998 and 1995 Waste Stream Base Costs by Waste Type (Millions of 1998$)

Waste Type	1998 Waste Stream	1995 Waste Stream	Difference
Commercial SNF	$4,858	$4,771	$87
HLW	$978	$904	$74
DOE SNF	$154	$0	$154
West Valley	$47	$58	($11)
Total	**$6,037**	**$5,733**	**$304**

Table C-5. 1998 and 1995 Waste Stream Total Costs by Waste Type (Millions of 1998$)

Waste Type	1998 Waste Stream	1995 Waste Stream	Difference
Commercial SNF	$5,554	$5,452	$102
HLW	$1,125	$1,039	$86
DOE SNF	$179	$0	$179
West Valley	$55	$69	($14)
Total	**$6,913**	**$6,560**	**$353**

Note that the differences in the above costs include several components: 1) capital costs, due to the increased number of transportation casks required; 2) shipping costs, due to the increased

number of shipments required; and 3) RSC performance awards and fees, which are proportional to the shipping costs.

C.2.2 Transportation Models and Assumptions

A number of changes in transportation models, assumptions, and data inputs were made for the 1998 WAST LCC Report. The principal changes are described below.

Rail Shipping Cost Algorithm - The 1995 WAST LCC Report calculated rail shipping costs using a formula developed for the RTDA (CRWMS M&O 1995b). This formula was based on 1986 rail tariff rates for loaded and unloaded radioactive material containers, modified to account for a recent (at the time) Interstate Commerce Commission decision that those rates (at least in one specific case) were unreasonably high (see Section 3.2.2.3.2.1).

Use of General Freight - A second major difference in transportation assumptions between the 1995 and 1998 WAST LCC Reports is the 1998 assumption that all transportation casks will be transported by General Freight, both to and from the MGR. In the 1995 WAST LCC Report, it was assumed that commercial SNF transportation casks would be shipped by dedicated trains to the MGR and by General Freight from the MGR. For HLW, it was assumed that dedicated trains would be used both ways. This assumption affects transportation costs in several ways: 1) the rail tariff rate is affected, since railroads add additional charges for dedicated trains; 2) the number of shipments is affected in two ways, since dedicated trains are assumed to contain up to three commercial SNF casks or five HLW casks (resulting in fewer shipments), and are assumed to travel at a higher average speed to the MGR; 3) the number of buffer cars and personnel cars required is affected due to the changing number of shipments; and 4) RSC fees and incentives are affected, since they are tied to shipping costs.

Security Costs - The 1995 WAST LCC Report shipping cost calculations calculated security costs based on two guards per train for 24 hours per day. Each guard was assumed to cost $0.19/mile (rail carrier charges) plus $250/day (labor costs). The rail shipping cost algorithm for the 1998 WAST LCC analysis includes the rail carrier charges for six security guards (two per shift, three shifts per day); the labor costs are calculated separately at $250/day per guard (1986$).

Use of Regions - The 1998 WAST LCC Report analysis divides the continental U.S. into four Regions, consistent with the Market-Driven Transportation Strategy (see Section C.2.4, below). This "regionalization" of the U.S. was not assumed in the 1995 WAST LCC Report. This has the effect of increasing capital costs, since the four Region model assumes no sharing of equipment between regions, thus creating inefficiencies in the use of casks and equipment.

Modal Split - The 1995 WAST LCC Report assumed that only four reactor sites would use LWT transportation. A more comprehensive analysis performed subsequently (CRWMS M&O 1995a) concluded that a conservative assumption of 13 truck sites is

warranted (later reduced to 11 based on more recent information). This effects both shipping costs (evaluated here) and capital costs (see section C.2.4).

Personnel and Buffer Rail Cars - As discussed in Section 3.2.2.2.2, it is assumed that two buffer cars and one personnel car are supplied by the RSC per train. It is further assumed that the RSC purchases these cars. The 1995 WAST LCC Report did not explicitly include the cost of buffer and personnel cars, although the RTDA (on which the 1995 analysis was based), Section 9.5.1, recognizes the need for such cars. The 1998 WAST LCC analysis results show that the costs of buffer and personnel cars are shown in Table C-6, below.

Table C-6. 1998 Buffer and Personnel Car Costs (Millions of 1998$)

Car Type	Base Cost	Contingency	Total Cost
Buffer Car	$13.10	$3.28	$16.38
Personnel Car	$32.75	$8.14	$40.94
Total	**$45.85**	**$11.42**	**$57.32**

Tables C-7 and C-8 show the cumulative effect of these modeling and data differences on the WAST shipping and transportation equipment costs.

Table C-7. Comparison of 1998 and 1995 Transportation Models (Base Cost, Millions of 1998$)

Cost Element	1998 LCC	1995 LCC	Difference
Shipping	$ 2,665	$940	$1,725
Transportation Equipment	$46	$0	$46
Total	**$2,711**	**$940**	**$1,771**

Table C-8. Comparison of 1998 and 1995 Transportation Models (Total Costs, Millions of 1998$)

Cost Element	1998 LCC	1995 LCC	Difference
Shipping	$ 3,065	$1,034	$2,031
Transportation Equipment	$57	$0	$57
Total	**$3,122**	**$1,034**	**$2,088**

Note that the costs shown in Tables C-7 and C-8 above are dependent on the assumed waste stream composition, so the difference between the 1998 and 1995 costs do not only reflect the difference in transportation models and assumptions.

C.2.3 Competitive Private Sector Transportation Strategy

A major scope change for the 1998 WAST LCC analysis is the competitive private sector transportation Strategy. As discussed in Section 3.2.2.4, RSCs will provide the waste acceptance and transportation services that were provided by the CRWMS Waste Acceptance and Transportation elements in the 1995 WAST LCC Report. To evaluate the effect of the competitive private sector transportation strategy on WAST life cycle costs, the costs for activities performed by the RSCs in the 1998 analysis (not including shipping costs or cask

purchase costs) were compared with costs for "like" activities from the 1995 WAST LCC Report. The results of this comparison includes Source Selection Information (see F.A.R. 3.104), and is contained in the Source Selection Sensitive version of this report (CRWMS M&O 1998. *1998 Waste Acceptance, Storage, and Transportation Life Cycle Cost Report.* Source Selection Sensitive Version. A10000000-01717-5708-00002 Rev. 00. August 1998. Vienna, Virginia: Civilian Radioactive Waste Management System, Management and Operating Contractor.).

C.2.4 Transportation Cask Fleet

The 1995 WAST LCC Report included a transportation cask fleet that consisted of only seven cask types:

- GA-4 (PWR) Legal Weight Truck Cask
- GA-9 (BWR) Legal Weight Truck Cask
- Large PWR MPC Rail Cask
- Large BWR MPC Rail Cask
- Small PWR MPC Rail Cask
- Small BWR MPC Rail Cask
- HLW Rail Cask

This cask fleet reflected the assumption at the time of the 1995 analysis that the MPC for transportation and disposal of SNF, and the assumption that all HLW canisters would have the same dimensions. Table C-9 shows the unit costs for these casks, escalated to 1998 dollars, along with the 1998 costs for the same casks. Table 12 in Section 3.2.2.2 shows the current cask fleet composition.

Table C-9. 1995 LCC Report Transportation Cask Costs[1] (Millions of 1998$)

	1995			1998			1998÷ 1995
Cask Type	Unit Cost	Decommissioning Cost	Total Cost	Unit Cost	Decommissioning Cost	Total Cost	
GA-4	$3.85	$0.12	$3.97	$2.62	$0.079	$2.70	0.68
GA-9	$3.85	$0.12	$3.97	$2.87	$0.086	$2.96	0.75
Large MPC	$2.97	$0.21	$3.18	$3.77	$0.294	$4.06	1.28
Small MPC	$2.42	$0.17	$2.59	$3.06	$0.214	$3.27	1.26
HLW [2]	$3.72	$0.26	$3.98	$3.72	$0.260	$3.98	1.00

1 - These are base costs, without contingency - the contingency factor is 25 percent
2 - for 1998, assumed to be the "short" Savannah River cask

In Addition, since only MPC SNF transportation casks were used in 1995, there are no costs for basket replacement included in the 1995 analysis.

In addition to cask unit costs, the modal split (i.e., the number of truck and rail sites) has changed since the 1995 WAST LCC analysis was performed (see Section C.2.3): instead of 4 truck sites,

there are now assumed to be 11 truck sites. This impacts the capital costs by changing the relative numbers of truck and rail casks required.

In order to estimate the effect transportation cask fleet/unit cost changes on WAST costs, a CALVIN run was made using 1998 waste stream and transportation models, with the 1995 cask fleet, modal split, and cask unit costs. This means that all SNF is assumed to be transported in MPC (DPC) casks, and all HLW is assumed to be transported in a single HLW cask type (this assumption is not realistic, since the Hanford HLW canister has different dimensions than the Savannah River HLW canister, therefore requiring a different cask). The results are shown in Table C-10, below.

Table C-10. 1998 WAST Cask Purchase Costs Using 1995 TSLCC Cask Fleet (Millions of 1998$)

	1998 Unit Costs & Cask Fleet	1995 Unit Costs & Cask Fleet	Difference
Base Cost	$593	$468	$125
Contingency	$148	$117	$31
Total Cost	**$741**	**$585**	**$156**

The net effect of the change in cask fleet from the 1995 TSLCC to the 1998 WAST LCC analysis is to increase cask purchase total costs by about $156 million. Note that these costs also include the effects of the revised waste stream, which increases cask purchase costs.

C.2.5 Waste Acceptance, Storage, and Transportation Scope Changes

In addition to the changes in WAST costs resulting from revisions to WAST models, assumption, and cost date, other cost changes have resulted from changes in the scope of WAST activities since the 1995 analysis. Four principle scope changes have occurred: 1) elimination of the MPC Subsystem; 2) addition of Nevada transportation costs; 3) changes in scope for the Waste Acceptance element as a result of the competitive private sector transportation strategy; an 4) reductions in scope for the Storage and PM&I elements.

C.2.5.1 Multi-Purpose Canister Subsystem Elimination

In the 1995 WAST LCC Report, it was assumed, consistent with the Program approach at the time, that all commercial SNF would be stored, transported, and disposed of in MPCs. For the 1998 analysis, the MPC has been eliminated, consistent with the current Program approach, which results in a decrease in WAST total life cycle costs of $6.192 billion. However, the elimination of the MPC results in an increase in MGR waste package costs, since the MPC was intended to act as part of the waste package for disposal.

C.2.5.2 Addition of Nevada Transportation Costs

The 1995 TSLCC included Nevada transportation costs in the MGDS (now MGR) element. The estimated cost (in 1998 $) was $914 million (including contingency). For the 1998 WAST LCC Report, Nevada transportation is included in WAST project costs. The Nevada transportation

costs calculated in Section 3.2.3 are $780 million (with contingency). Therefore, the overall impact on total system costs is a reduction of $134 million (1998$).

C.2.5.3 Waste Acceptance Scope Changes

As discussed in Section C.2.3, many of the Waste Acceptance services that were provided by the Waste Acceptance element in the 1995 WAST LCC Report have been transferred to the RSCs under the competitive private sector transportation strategy. This results in a reduction in Waste Acceptance costs of $1.235 billion.

C.2.5.4 Storage and Project Management and Integration Scope Changes

Changes have also made to the scope of Storage and PM&I element activities since the 1995 analysis. The difference in Storage element costs between 1998 and 1995 can be attributed to the elimination of projected costs for storage technology demonstration projects, such as development of automated canister welding technologies and support of dry transfer system development. These costs were at least in part related to support of MPC subsystem development.

The reduction in PM&I costs reflects the overall reduction in WAST D&E activities prior to 2010, including elimination of the MPC subsystem and transfer of many Waste Acceptance functions to the RSCs as part of the competitive private sector transportation strategy.